Vol. VIII.—No. 39.] [MAY, 1889.

THE

MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

Mineralogical Society.

[2 PLATES.]

INSTITUTED 3rd FEBRUARY, 1876.

EDITED BY A COMMITTEE OF COUNCIL.

Reprinted 1965 for
Wm. DAWSON & SONS LTD., LONDON
with the permission of
THE MINERALOGICAL SOCIETY

Mineralogical Society.

OFFICERS AND COUNCIL FOR 1888-89.

PRESIDENT.

R. H. SCOTT, M.A., F.R.S.

PAST-PRESIDENTS.

H. C. SORBY, LL.D., F.R.S. 1876–1879.
PROF. M. F. HEDDLE, M.D., F.R.S.E. 1879–1881.
W. H. HUDLESTON, M.A., F.R.S. 1881–1883.
REV. PROF. T. G. BONNEY, D.Sc., F.R.S. 1883–1885.
L. FLETCHER, M.A., F.G.S., 1885-1888.

VICE-PRESIDENTS.

THE REV. PROFESSOR HAUGHTON, M.D., F.R.S.
HUGO MÜLLER, Ph.D., F.R.S.

COUNCIL.

PROF. J. W. JUDD, F.R.S.
PROF. E. KINCH, F.C.S.
PROF. W. I. MACADAM, F.C.S.
J. J. H. TEALL, M.A., F.G.S.
PROF. A. H. CHURCH, M.A., F.R.S.
TOWNSHEND M. HALL, F.G.S.
MAJ.-GEN. C. A. McMAHON, F.G.S.
J. STUART THOMSON.
C. A. BURGHARDT, Ph.D., F.C.S.
H. A. MIERS, M.A., F.G.S.
R. H. SOLLY, M.A., F.G.S.
J. M. THOMSON, F.R.S.E., F.C.S.

TRUSTEES.

THE RIGHT HON. LORD DE BLAQUIERE, F.R.G.S.
PATRICK DUDGEON, F.R.S.E.

TREASURER.

THE REV. PROFESSOR T. G. BONNEY, M.A., D.Sc., F.R.S.

GENERAL SECRETARY.

L. FLETCHER, M.A., 36 Woodville Road, Ealing.

FOREIGN SECRETARY.

T. DAVIES, F.G.S.

AUDITORS.

B. KITTO, F.G.S.
F. W. RUDLER, F.G.S.

GENERAL MEETING.

Held on the Premises of the Geological Society, January 22nd, 1889.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read :—

"On Connellite from South Africa." By G. T. Prior, M.A. (p. 182.)

"On Pseudomorphs of Hæmatite after Iron Pyrites." By R. H. Solly, M.A., F.G.S. "With an Analysis by A. Hutchinson, B.A." (p. 183.)

"On Crystals of Percylite, Caracolite, and an Oxychloride of Lead (Daviesite), from Mina Beatriz, Sierra Gorda, Atacama." By L. Fletcher, M.A. (p. 171.)

Abstract of a paper "On the Distribution and Origin of the Hydrocarbons of the Old Red Sandstone of Ross and Cromarty," by Hugh Miller, F.R.S.E., H.M. Geological Survey. (Communicated and read by the Secretary.)

On the invitation of the President, Mr. Hyland, a visitor, gave an account of the results of his examination of the Soda-microcline from Kilima-njaro.

Specimens of Sperrylite, a compound of Platinum and Arsenic, were exhibited by Dr. Hugo Müller, F.R.S., and by Mr. L. Fletcher. Specimens illustrative of the papers of Mr. Solly and Mr. Fletcher were also shown.

EXCERPT MINUTES OF COUNCIL MEETING.

Held on the Premises of the Geological Society, January 22nd, 1889.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following were appointed Members of the Editing Committee :—

Mr. R. H. Scott, President. Mr. T. Davies. Mr. W. H. Hudleston.
Prof. E. Kinch. Mr. L. Fletcher, General Secretary.

The following resignations were received :—

Mr. James Currie. M. Guyot de Grandmaison.

Mr. Nuna Daniel Davis was elected a Member.

The death of Professor T. Kjerulf, Corresponding Member, was announced.

It was reported that the Council of the Geological Society had graciously consented to allow its rooms to be used for the meetings of the Mineralogical Society.

A proposal to exchange publications with the Royal Institution of Cornwall was accepted.

EXCERPT MINUTES OF COUNCIL MEETING.

Held on the Premises of the Geological Society, February 18th, 1889.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The audited Balance Sheet for the year 1888 was submitted, and ordered to be issued with the next number of the Journal. (p. viii.)

Mr. B. H. Woodward, F.G.S., was reinstated as Member.

The death of Mr. T. A. Readwin was announced.

It was resolved to hold two additional General Meetings in London during the current year, on March 12th and June 25th respectively.

GENERAL MEETING.

Held on the Premises of the Geological Society, March 12th, 1889.

R. H. Scott, Esq., M.A., F.R.S., President, in the Chair.

The following papers were read:—

"On Dudgeonite, Hydroplumbite and Plattnerite; and on the occurrence of Gyrolite in India." By Professor M. Forster Heddle, M.D. F.R.S.E. (pp. 199, 200.)

"On the processes by which a Plagioclase-felspar is converted into Scapolite." By Professor J. W. Judd, F.R.S. (p. 186.)

"Notes on Aragonite." By R. H. Solly, M.A., F.G.S.

"Mineralogical Notes." By H. A. Miers, M.A., F.G.S. (p. 204.)

"On the Meteorites of Imilac, Mantos Blancos and Serrania de Varas By L. Fletcher, M.A.

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 39. MAY 1889. Vol. VIII.

On Crystals of Percylite, Caracolite, and an Oxychloride of Lead (Daviesite), from Mina Beatriz, Sierra Gorda, Atacama, South America.

By L. Fletcher, M.A., F.G.S.

[Read January 22nd, 1889.]

SOME time ago a specimen studded with small but well developed crystals of a sky-blue mineral, supposed to be percylite, was offered for the British Museum collection: the rarity of percylite and the excellence of the crystals on this specimen rendered a careful examination desirable. The specimen had been obtained from the Mina Beatriz, Sierra Gorda: on a large-scale chart, kindly placed at my service some years ago by Mr. George Hicks, of Newquay, Cornwall, Sierra Gorda is shown situate between the Bay of Mejillones and Caracoles, about 20 or 30 miles from the latter; longitude 69°29′ W. of Greenwich, latitude 22°55′ S.: at the truce of 1884 possession of this district was temporarily assigned to Chili.

On measurement one of the crystals proved to belong to the cubic system, and to be limited by the faces of the rhombic dodecahedron, octahedron and cube, those of the latter being subordinate in development;

on other crystals the cube was seen to be a predominating form: the mineral is without action on polarised light: by help of the blowpipe the presence of copper, lead and chlorine was recognised: hence the crystals are doubtless percylite.

The crystals are sprinkled upon calcite which presents here and there large cleavage-faces, and is coated in parts with a white powder containing both calcium and sulphuric acid: limonite and crystals of chlorargyrite are also present.

On the mention of a wish to see other specimens from the same mine for the purpose of determining the associations of the percylite, 37 other specimens were sent for examination. The following minerals were recognised:—Cleavable masses of sulphide of lead (galena), massive sulphate of lead (anglesite) very dark in colour, yellow coatings of antimonate of lead (bindheimite), chromate of lead (crocoite), molybdate of lead (wulfenite) in very small crystals, sometimes yellow, sometimes red: fine cubo-octahedra of chloride of silver (chlorargyrite), and crystalline iodide of silver (iodargyrite): massive silicate of copper (chrysocolla), and pulverulent blue carbonate of copper (chessylite): quartz, both in minute crystals and massive: a powder giving the reactions of sodium sulphate: pulverulent limonite: calcite in small encrusting crystals and cleavable masses: gypsum both pulverulent and cleavable.

One of the wulfenite crystals was measured and found to have the form of the pyramid $e\{011\}$, the two apices being replaced by relatively large faces of the basal pinakoid $e\{001\}$, and the four lateral quoins by pairs of small faces of the pyramid $n\{111\}$. (Fig. 1, Plate VIII.)

These minerals, percylite included, have all been recognised by Raimondi as occurring also in Peru, where most of the lead minerals, as is pointed out in his treatise, are secondary products resulting from the decomposition of the widely occurring bournonite and galena.

A single specimen from Mina Beatriz shows numerous small crystals, the nature of which was not at first apparent. They are deposited on a matrix which consists largely of massive anglesite associated with massive percylite, and is coated with bindheimite.

The crystals reach occasionally a millimetre in diameter: they are either colourless or patched with green, are hexagonal in development, and have the shape represented in Fig. 2. The hexagonal basis is a dull face rounded in the direction of the adjacent pyramidal planes, and affords no measurements on the goniometer: the other faces are bright and smooth, but generally give more than one image.

The most satisfactory measurements obtained from three crystals lead to the following angles :—

ax 50°8′ (mean of the 11 angles 49°56′, 49°58′, 49°59′, 50°0′, 50°3′, 50°6′, 50°9′, 50°13′, 50°18′, 50°18½′, 50°28′).

xx 36°59′, 37°3′, 37°6′: 37°23′, 37°28′: 37°42½′: 37°55′.

aa 58°48′, 59°3′, 59°58′, 60°26′, 61°13′, 58°51′ or 59°27′ (alternative images), 59°27′ or 60°3′, 60°20′ or 61°50′.

The general aspect of the crystals and the magnitudes of the angles made it probable that the mineral was identical with one described in 1886, in a posthumous paper of Professor Websky,[1] and named by him caracolite: the habit of both is the same, and the means of correspondingly variant angles are given by him as

ax 50°8′, *xx* 37°44′, and *aa* 60°36′

respectively. The approximate chemical formula assigned by Websky, on the basis of a qualitative examination of the crystals and a quantitative analysis of the mixed matrix, is $2Na_2SO_4 \cdot PbCl_2 \cdot PbO \cdot H_2O$.

The crystallised crust, from which the crystals occasionally project and which is apparently of the same material, was found on blowpipe examination to contain the elements sodium, lead, chlorine and sulphur found by Websky in caracolite: further, transparent particles picked from the minute fragments removed by a needle-point from the crust were found to be similarly acted upon by water; they become white and opaque and are partially dissolved, the solution giving a rich yellow colour to a Bunsen flame. It may be added that on spontaneous evaporation minute square-faced crystals, with occasionally a pyramidal depression, are deposited from the solution: they are without action on polarised light, and are probably sodium chloride. The part insoluble in water dissolved slowly and almost completely on warming for some time in dilute nitric acid. The identity of the mineral with caracolite is thus beyond doubt.

Websky found that when the crystals were examined in polarised light they afforded aggregate depolarisation, and that when reduced to minute splinters, not before, a sharp line of demarcation between distinct individuals was visible. From this he inferred that the hexagonality is due to twin-growth.

We may observe that in its crystalline habit and its angles caracolite is very similar to mimetite, which has been proved to be optically biaxal and thus only pseudo-hexagonal in its facial symmetry; the corresponding angles for that mineral are given by Brooke and Miller as :—

ax 49°6′, *xx* 38°12′, *aa* 60°0′ :

[1] *Sitz. Ak. Berlin :* 1886, p. 1045.

further, the angles of the principal zone $a\,x\,o$ of caracolite are nearly those of the prominent zone $b\,d\,c$ of anglesite, $b\,d$ (010·012) being for that mineral 50°37½′. On one of the crystals from Mina Beatriz very minute faces are visible in the zone $a\,a$, and truncate the edges of the prism: other crystals still on the matrix show a face replacing one of the edges of the pyramid x. On Websky's crystals a confirmation of the twin-structure was afforded by the occasional furrowing of the edges of the pyramid.

On the specimen which furnished the caracolite, and in the immediate neighbourhood of some of the crystals, was a small cavity only two millimetres in diameter, from the sides of which very minute elongated clear colourless crystals, of vitreous to adamantine lustre, were seen to project. No crystals of the same kind were visible on other parts of this or on any of the remaining specimens. The material from which they spring is colourless or white at their bases, but farther away has a brownish tinge: the latter part was found to contain the elements lead, sodium, chlorine, and sulphur present in the caracolite, though the proportion of sulphur seemed to be less and thus to suggest an admixture of caracolite with one or more minerals less rich in sulphuric acid. The crystals are less than one millimetre in length, and are about one-sixth of a millimetre wide: they are still smaller in thickness.

When mounted for measurement on the reflecting goniometer and viewed with the highest power, they were seen to be very well developed, some being terminated by numerous minute faces. Ten crystals were measured and found to belong to the orthorhombic system; but only five gave results of value for the determination of the parametral angles: the faces often give more than one good image, and on one crystal prism-faces which ought to be parallel are inclined at an angle of 176°-177°.

The parametral angles are

011·010 58°58′, 101·001 25°32′, 110·100 51°33′,

and the parametral ratios are

$$a:b:c = 1{\cdot}2594:1:0{\cdot}6018.$$

The prism-zone is constant in character, the prism m {110} having always two opposite edges replaced by the faces of the pinakoid a {100}; the latter faces are generally larger than those of the prism. As the crystals have one end of the prism in the matrix, only one extremity is terminated by faces. In two cases the crystal is terminated by the basal pinakoid c {001}, as shown in Fig. 3: in another crystal the basal pinakoid is absent and its place is taken by two domes f {101}, g {301} (Fig. 4): in another appear small faces of a third tautozonal dome h {501}, a

urth dome *e* {031} in the perpendicular zone, and also octahedrid forms {521}, *v* {221}, *t* {121} and *s* {211}, giving rise to the zones *a r v t*, m_1 r_1 s t e $\bar{m}_1$, m_1 s_1 f d t'_1 $\bar{m}_1$, r h r_1 (Figs. 6 and 7); in this crystal the forms *v e* re represented only by single and very minute faces. On the termination of nother crystal (Fig. 6) the dome *d* {011} presents itself, and is associated ith the forms *c f r* and other faces too rounded to have definite indices ssigned to them. Several of these minute faces give a faint image of the lit when observed with the δ-eyepiece of a Fuess-goniometer, but most of hem not only give no image of the slit but are themselves only visible hen the slit is removed, and all the light transmissible by the collimator made use of: the angles can then be measured by the method of naximum illumination, and with a certain amount of precision owing to he smoothness of the minute faces. The forms observed were *a* {100}, {001}, *d* {011}, *e* {031}, *f* {101}, *g* {301}, *h* {501}, *s* {211}, *t* {121}, *v* {221}, {521}: a stereographic projection of the poles is given in Fig. 7.

When the face *a* is striated, its striæ are perpendicular to the edges of he prism.

One crystal has a face of the form *f* {101} on the end which had been m the matrix, and that face may possibly be due to cleavage.

The following is a list of calculated and observed angles:—

Angles.	Calculated.	Observed.
am	51°33′	Mean 51°33′ (50°58′, 51°1′, 51°9½′, 51°29½′, 51°29½′, 51°31′, 51°33′, 51°35′, 51°38′, 51°44′, 51°44′, 51°45′, 51°58′, 52°12′: all images)
cd	31°2′	31°8′ image
af	64°28′	64°51′ image
cf	25°32′	25°
ag	34°54′	34°21′ image
fg	29°34′	29°2′, 29°24′, 29°36′
hg	12°11′	11°30′, 11°51′
ff′	51°5′	51°37′
ar	33°13½′	33°20½′ image
rv	25°22′	26°33′
vt_1'	48°24′	47°22′
rt	39°48′	39°22′, 39°39′, 40°21′
tt_1'	33°58′	33°21′

Angles.	Calculated.	Observed.
mr	31°45½′	30°14′ – 31°44′ band of images
rg	27°35′	27°40′, 28°18′
mg	59°20′	59°25′ image
gs_1	25°59′	26°28′
s_1t_1	27°54½′	27°27′
t_1e'	20°0½′	20°37′
ms	45°3½′	45°42′
sf	29°23½′	28°23′ : 29° : 29¼°
mf	74°27′	74°9′ image
fd'	39°22′	39¼°
ft'	64°49′	65°45′
md	66°11′	66°22′ image : 66°, 66¼°
mf'	105°33′	105°7′
rr_1	49°51′	49°50′ image
as	50°41′	50¾°

As no correspondence could be found between the angles of these crystals and those of any known mineral, it became necessary to determine as completely as possible the characters of the mineral without trespassing too much on the material in the minute cavity: as the matrix might not be identical in its composition with the projecting crystals, the experiments must of necessity be made on the crystals themselves.

The following results were obtained:—

1. A crystal sinks quickly in a liquid of specific gravity exceeding 3.

2. On examination in parallel polarised light, the edges of the prism are seen to be parallel to a direction of extinction.

3. In convergent polarised light no optic axes are visible through the face a.

4. By means of a quartz-wedge it was found that for the face a the direction of the prism-edge is that of the least optic elasticity.

5. A crystal boiled for some time in water remains unaltered: water at the ordinary temperature has not the slightest action when the contact is continued during eight weeks.

6. A crystal placed in distilled water in a concave glass and watched with the microscope, dissolves quickly without the least trace of effervescence on the addition of a drop or two of nitric acid.

7. When, instead of nitric acid, sulphuric acid is dropped into the

water, solution without effervescence takes place, but opaque isolated particles are left behind, and these are for a time connected by an invisible substance having the shape of the original crystal, for the opaque particles move simultaneously without changing their relative positions when the watch-glass is tilted to one side.

8. A solution in hydrochloric acid gives no coloration to the flame.

9. Fused with sodium carbonate on charcoal a crystal yields a malleable metallic metal: the products of fusion when moistened with water give no stain to a silver coin.

10. Solutions in nitric acid were subjected to wet tests in capillary tubes with the following results:—Barium chloride gave no visible precipitate: molybdic solution gave neither precipitate nor coloration: silver nitrate gave a minute but distinct turbidity.

11. A crystal in a tube closed at one end was heated in an air-bath at various temperatures up to 300° C., but though at the highest temperature the crystal became a shade whiter and the tube became slightly clouded there was no appreciable decomposition: the crystal retained its transparency and the brilliancy of its faces, and its prism-edge remained a direction of optical extinction.

12. A crystal in a tube closed at one end was heated slowly over a Bunsen-burner and carefully watched: up to a considerable temperature no alteration was observed: the crystal then flew to pieces, but the fragments were still clear and colourless: on exposure to a temperature at which the glass began to melt the bits became white and opaque, but remained fairly sharp in outline, though possibly owing to union with the melted glass; there was scarcely any perceptible clouding of the tube.

From the above it follows that the crystals differ from caracolite and the matrix not far from their base: they contain neither sodium nor sulphuric acid, but lead and chlorine enter into their composition. They are distinguished from the native chloride of lead, cotunnite, not only by their angles (which do indeed present some similarity), but also by their insolubility in water: chemically they must in all probability be an oxychloride of lead.

Several native oxychlorides of lead are already known, namely, fiedlerite of unknown chemical formula, matlockite $PbCl_2 \cdot PbO$, laurionite $PbCl_2 \cdot PbO \cdot H_2O$, and mendipite $PbCl_2 \cdot 2PbO$. Of these the recently discovered fiedlerite belongs, according to the late Professor vom Rath, to the monosymmetric system, and matlockite crystallises in the tetragonal system; further, both have angles quite distinct from those of the crystals

under consideration. The rare mineral laurionite,[1] found along with fiedlerite in an ancient lead-slag, described by Köchlin and later by vom Rath, belongs to the orthorhombic system, and presents some similarity in the development of its crystals: it is quite distinct, however, in its angles, and it begins to part with water at a temperature of about 142°C.

There still remains mendipite: this mineral has been found at only two localities, one of them in the Mendip Hills, the other in Westphalia. The white opaque crystals from the neighbourhood of Tarnowitz in Silesia, though known for some time as "chloride of lead" or "mendipite," were long ago proved to be altered cromfordite, and to be more or less changed to cerussite. At both its localities the mineral occurs as columnar cleavable masses, and it has not yet been found presenting crystal-faces. Its assignment to the orthorhombic system depends on the cleavages and optical characters. The only crystallographic element of mendipite known is the angle between its easy cleavages: this is given by Haidinger as 102°27′, by Breithaupt as 102°30′, by Brooke and Miller as 102°36′, and measurement by myself of a single edge gave 102°41′. Now the mean prism-angle of the crystals under consideration is 103°6′, and though differing from the observed cleavage-angle of mendipite, the difference is not so large, having regard to the variation in the observed angles, as to be convincing in itself of a difference in the specific character of these crystals and mendipite.

It seemed, however, that the crystals from Mina Beatriz were much more quickly dissolved by nitric acid than were fragments of mendipite: to get an idea of the rate of solution of mendipite, matlockite and cotunnite, minute fragments of those minerals were placed in nitric acid on watch-glasses and left standing at the temperature of the laboratory: the mendipite disappeared in 93 minutes, the cotunnite in 182 minutes, and the matlockite in 215 minutes. As these fragments, though minute, were larger than the crystals under examination, a more direct comparison was made: one of the Mina Beatriz crystals and a cleavage-fragment of true mendipite were placed alongside each other in distilled water and observed with the microscope: the crystal was longer than the mendipite fragment and about the same width, but the two may not have been of exactly equal thickness: the crystal was perfectly clear and free from flaws, while the mendipite was striated by its cleavages and thus not so permeable to light. Nitric acid was dropped on the edge of the water at the spot to which the crystal and fragment both pointed, and would reach the two simultaneously: the

[1] *Ann. d. k.k. naturhist. Hofmuseums:* 1887, Vol. II. p. 188. *Sitz. d. niederrhein. Gesell. in Bonn:* 1887, *Jahrgang* 44, p. 149.

crystal disappeared completely in 52 seconds, the mendipite in 142 seconds. If allowance be made for the time taken by the acid to reach the specimens the numerical difference of solubility will appear still greater. The absence of identity of structure would scarcely account for this difference in the rate of action of the nitric acid, for the striated character and lesser compactness of the mendipite should tell in its favour.

Again, a fragment of mendipite heated in a tube closed at one end fuses quite readily and spreads itself over the glass, yielding a product of a yellowish brown colour.

Further, while mendipite, as we have said, has a pair of easy cleavages, the crystals under consideration are without cracks, and when broken under oil still fail to give any cleavage-evidence when examined in the microscope. The crystals break across the prism with a sub-conchoidal fracture, and show no cleavage parallel to the basal plane: the only suggestion of cleavage was that already mentioned, namely, a crystal-face f at the matrical end of a crystal.

Finally, an extremely small fragment terminated by a good basal plane was so placed in a drop of water on a microscopic slide that it could be looked through by convergent polarised light having an axial direction not far from normal to the terminal face: brushes were now seen: the position of one of the optic axes was near the edge, that of the other, owing to the slightly skew position of the fragment, was just outside the field: the plane of the optic axes was perpendicular to the face a: the hyperbolic brush passing through the optic axis in the field was distinctly blue on its concave side, and was not perceptibly coloured on the convex side.

In addition to the native oxychlorides of lead above mentioned, there are at least four others known as artificial products: they have the following formulæ: ($3PbCl_2 \cdot PbO$), ($PbCl_2 \cdot 3PbO$), ($PbCl_2 \cdot 5PbO$), ($PbCl_2 \cdot 7PbO$).

Since the above observations were made my attention has been called to a description of some mineral specimens from Sierra Gorda, published two years ago by Professor Sandberger,[1] one of the Corresponding Members of our Society. Caracolite, percylite, wulfenite, crocoite and other minerals were recognised by him: and he further points out that the specimen described by Websky was in all probability brought from the same locality and not from Caracoles itself.

Both Professor Sandberger and myself have failed to confirm the presence of water either in crystals of percylite or caracolite; both minerals give

[1] *Neues Jahrbuch für Mineralogie*, 1886, Vol. I. p. 89; 1887, Vol. II. p. 75.

fumes and a crystalline colourless transparent sublimate when heated in a tube closed at one end, and in the case of percylite at least the sublimate fuses to a colourless liquid.

It being necessary, for purposes of reference at least, to give a name to the oxychloride of lead above described, I venture to suggest the name *Daviesite*, in honour of Mr. Thomas Davies, F.G.S., who has now been associated during upwards of thirty years with the British Museum Mineral Collection, and whose mineralogical experience and Breithauptian eye have ever been willingly placed at the service, not only of his colleagues, but of every one who has been brought into relationship with him.

Note on Colorado Hydrophane.

By A. H. Church, M.A., F.R.S.

[Read January 22nd, 1889.]

SOME experiments on the hydrophane recently found in Colorado led Mr. G. F. Kunz (*Am. J. Sc.* XXXIV. pp. 479-480, Dec. 1887) to the extraordinary conclusion that this mineral absorbed more than its own bulk of water. Mr. Kunz, with great kindness, furnished me with a supply of this variety of opal from the locality in question. I can confirm the accuracy of his experimental results, but not of his deductions therefrom.

A flat piece of this hydrophane weighing ·578 gram absorbed ·276 gram of water, becoming nearly transparent. This amount corresponds to an addition of 47·75 parts of water to 100 of opal, so that the saturated hydrophane contained 32·43 per cent. of water. I determined the volume of the mineral, both in the dry and wet state, by weighing the quantity of pure mercury which it displaced from a small glass cup (with a covering plate) full of that metal. In this way I proved that the volume of the wet hydrophane was identical with that of the dry. The mean weight of mercury displaced in several experiments was 7·415 grams. This, corrected for temperature and reduced to its equivalent volume and weight of water, corresponds to ·546 cub. cent. or grams, and gives 1·06 as the specific gravity of the dry hydrophane.

From the above data—namely, ·546 cub. cent. for the volume of the hydrophane, and ·276 cub. cent. for the volume of the water it absorbs—we reach the conclusion that 1,000 volumes of hydrophane absorb 505 volumes of water, that is, just over half the original volume of the mineral.

As there is room for the imbibition of ·276 cub. cent. of water in the piece of hydrophane with which my experiments were made, we may conclude that the actual opal-substance therein occupies the space of ·270 cub. cent. only, out of the total volume of ·546. For ·546 − ·276 = ·270. We deduce thence the figure 2·14 for the specific gravity of the opal-substance free from interstitial air. Mr. Kunz, by the ordinary method of weighing in air and then in water, obtained the figure 2·122 for the specimens with which he worked.

Note on Connellite from a New Locality.

By G. T. Prior, M.A.

[Read January 22nd, 1889.]

THE locality of the specimen which is the subject of the present note is Namaqualand, South Africa. It was brought over from Africa, together with other minerals, about the year 1861, by Mr. Edgar Layard, who was at that time acting as curator of the Museum at Cape Town. It was in the same year that Mr. Layard presented to the British Museum Collection specimens of Namaqualite, the mineral which was subsequently examined by Professor Church and shown to be a new species. The connellite was given by Mr. Layard, among other specimens, to Mr. T. Davies, who in 1887 presented it to the Museum. It was not recognised as certainly connellite, but was put aside for chemical examination as being either clinoclase or connellite.

The connellite on the specimen consists of a small radiating group of acicular crystals lying quite flat on the matrix, together with a few smaller patches not so well defined. Fragments from one of the latter were taken for a qualitative examination. The mineral was freely soluble in nitric and hydrochloric acid, and during solution under the microscope each fragment was seen to consist of a bundle of minute needles presenting the fine dark Prussian-blue colour characteristic of connellite, and showing, as they became more transparent under the action of the solvent, straight extinction between crossed nicols. Perfectly definite reactions for copper chloride and sulphate were given by the usual qualitative tests.

The minerals accompanying the connellite on the specimen are massive cuprite, malachite and quartz: the connellite is deposited on the cuprite. No atacamite or chrysocolla could be detected.

Pseudomorphs of Hæmatite after Iron Pyrites.

By R. H. Solly, M.A., F.G.S.
With an Analysis by A. Hutchinson, B.A.

[Read January 22nd, 1889.]

LAST Easter, when I was with Professor Hughes and his geological students at Torquay, I found some very perfectly preserved pseudomorphs of hæmatite after iron pyrites. They occur in the calcareous red shale in the most northerly part of Saltern Cove, Torquay, where the unconformity of the Trias and the Devonian is well shown.

The crystals vary in size from small to large peas, and are in a band about half-a-foot wide in a nearly horizontal position in the cliff facing the sea, while on the north side of this small promontory they appear in a similar manner, but making an angle of about 120° to the horizontal band.

It is pretty certain from the arrangement of the fossils found at this spot that the two bands were originally in parallel position, and have been brought into their present position by later earth-movements. The form of the crystals is that of a cube striated parallel to the intersection of the {100} and π {210} faces; on some of the crystals the face π {210} is well developed.

The crystals have a hardness of 4 to 5, and a density 4·5, similar to that of massive hæmatite; streak, reddish-brown; when broken are compact inside; sometimes accompanied with veins of calcite.

The other recorded occurrences of these pseudomorphs are :—

From Rio π {210}, described by vom Rath. *Zeit. geol. Ges. Berl.* XXII. p. 707.

Beresovsk, Siberia {100}, with quartz in granite. Ullmann, 1814, *Syst. Min.* p. 309.

Piedmont {100}. *Blum. Pseud.* I. p. 187.

Platten, Bohemia, π {210} {111}. *Blum. Pseud.* p. 188.

Quicksilver mine, Potz Int. π {210}. *Blum. Pseud.* II. p. 187.

Stahl, near Moschel, Rhenish Bavaria.

Saalfeld in Thuringia. *Blum.* III. p. 180.

Eibenstock, Saxony. *Blum.* III. p. 180.

Kerrara Sound, Argyllshire. Heddle.

Elba π {210} {100}. *Blum.* IV. p. 103.

Sarbalberges, Hungary {100}, Madelung. *Jahrb. geol. Reichs.* XIV. p. 287-8.

Glengavin, Leadhills. Heddle.

S. Joaod' Ypanema, S. Brazil; {100} Rosenbusch. *Ber. nat. Ges. Freiberg* 1870. p. 537.

Berggieshübel, Saxony; British Museum collection.

Ardbarrow Mine, Millom, Cumberland; British Museum collection.

Spitzleite, Schneeberg, Saxony; British Museum collection.

Johann-Georgenstadt, Saxony; {100} Cambridge collection.

The pseudomorphs of brown iron oxide after iron pyrites are much greater in number. Can this be in some way accounted for by the production of red hæmatite taking place subsequently to that of the brown iron oxide, and not directly from the iron pyrites? Such a view is put forward by Bischof.

The crystals from S. Joaod' Ypanema contain a kernel of soft brown iron oxide, and therefore point to such a production. But there is another way of accounting for it. If a piece of calcite or other form of carbonate of lime be placed in a solution of ferric chloride, a deposition of red oxide of iron takes place.

The presence of carbonate of lime in large quantities in the rocks about Torquay has most likely caused the iron in solution percolating through the rock as ferric chloride (from the salt water above) to be deposited as red oxide of iron instead of a brown oxide, and from the same cause the iron pyrites has been changed directly into red oxide of iron instead of into the more common form of brown oxide of iron.

These pseudomorphs should be placed in the division of partial allomorphs. Below is Mr. Hutchinson's account of his analysis:—

"Before commencing the analysis I determined the specific gravity of these crystals, dividing them for this purpose into two lots.

A. Well developed crystals weighing in all 1·9 grams.

B. Less perfect crystals weighing 4·5 grams. Each crystal was carefully scraped free from adhering matrix, and the following values were obtained:—

A = 4·59 at 15° compared with water at 15° C.

B = 4·52 „ „ „ „

B was then reduced to a fine powder; a portion subjected to a preliminary qualitative analysis was found to contain ferric oxide, alumina, silica, calcium carbonate, water and sulphur.

Dilute acid dissolved out the whole of the calcium carbonate, and all the iron was present in the ferric state.

For the quantitative analysis successive portions were taken; in one of

these the sulphur was determined, the mineral being treated with fuming nitric acid and the sulphur precipitated as $BaSO_4$. This sulphur is assumed to be due to the presence of iron pyrites, and the amount of this substance given in the analysis below is calculated on this assumption. In a second portion water and CO_2 were determined.

Three other portions were reduced in hydrogen, and two of them dissolved in dilute sulphuric acid, the iron was then estimated by titration with potassium permanganate.

The third portion was dissolved in hydrochloric acid, and the silica, iron, alumina and calcium carbonate separated gravimetrically by the usual methods ; the numbers thus obtained gave the following percentages :—

Fe_2O_3	=	85·29
FeS_2	=	1·78
SiO_2	=	4·29
Al_2O_3	=	3·18
$CaCO_3$	=	5·37
H_2O	=	·71
		100·62

On the Processes by which a Plagioclase Felspar is converted into a Scapolite.

(With a Plate.)

By Prof. John W. Judd, F.R.S., F.G.S.

[Read March 12th, 1889.]

FEW mineralogical problems are of greater interest at the present time than those connected with the metamorphism of rocks. We are called upon to determine the exact series of processes by which a rock, having a particular texture and consisting of certain mineral species, is converted into a totally dissimilar rock, possessing, not only a different structure, but a distinct mineralogical constitution.

No example of the kind offers a better opportunity for studies of the class to which I refer than the celebrated "apatitbringer," or hornblende-scapolite-rock of Oedegaarden, near Bamle, in Norway. Many observations in the field go to prove that a pyroxene-felspar-rock has in this case been converted into a hornblende-scapolite-rock; and the beautiful experimental investigations of MM. Fouqué and Michel-Lévy have shown that, by fusion and slow cooling, the hornblende-scapolite-rock is, in turn, converted back again into a felspar-pyroxene-rock.

By the kindness of a friend and former pupil, Mr. Eger, who is the Director of the celebrated Apatite Mines of Oedegaarden, near Bamle, in Southern Norway, I have had placed at my disposal an interesting series of specimens, which has enabled me to carry out the investigations described in the following paper.

Attention was first called to the remarkable rock of Oedegaarden by Brögger and Reusch in 1875;[1] these authors styling the rock a "gefleckter gabbro." The rock was also described in 1877 by H. Möhl.[2] In 1878 Lang expressed a suspicion that the rock contained a mineral of the Scapolite group,[3] and in the same year the presence of Scapolite was fully demonstrated by Michel-Lévy.[4]

---

[1] *Zeitschr. d. deutsch. geol. Gesellsch.* Vol. XXVII. p. 749.

[2] *Nyt. Magazin for Naturwidenskaberne.* Bd. XXIII. (1877) pp. 75-77, T. II. Fig. 4.

[3] *Zeitschr. d. deutsch. geol. Gesellsch.* Vol. XXXI. p. 503.

[4] *Bull. Soc Min. Fr.* 1878, pp. 43-46, 79-81. See also Fouqué and Michel-Lévy, *Minéralogie Micrographique* (1879). Plate XXXVII. fig. 1.

In the following year (1879) MM. Fouqué and Michel-Lévy made the important announcement that, by fusing the hornblende-scapolite-rock of Oedegaarden with a trace of sodic fluoride, they had succeeded in producing a rock composed of pyroxene and labradorite.[1]

In 1883 Sjögren gave some additional details concerning the mode of occurrence and association of the rocks of the district, all of which pointed to the conclusion that the hornblende-scapolite-rock had resulted from the metamorphism of a pyroxene-felspar-rock.[2]

Many examples of the occurrence of scapolite in the crystalline schists have been described by Becke, Törnebohm, Dathe, Wulf, Mügge and others; and Svedmark has described a rock from Orebrö, in Sweden, having a very similar mineralogical constitution to the Oedegaarden rock;[3] while still more recently Lacroix and Baret have given an account of a pyroxene-hornblende-scapolite-rock from Point-du-Jour, near St. Nazaire, in France.[4]

At the meeting of the British Association at Montreal in 1884, Mr. F. D. Adams announced the existence of scapolite-rocks in Canada, where, however, a connection with the important Apatite-deposits of that country does not as yet seem to have been proved.[5]

In 1887 Dr. A. P. Coleman showed in his study of the Petrography of the Drift of Central Ontario that masses of scapolite-diorite-schist occur as erratic blocks in that district.[6]

Quite recently, Mr. F. D. Adams and Dr. Andrew C. Lawson have given an admirable account of the chief characteristics of the scapolite-bearing rocks in Canada; and in the sequel I shall have to refer to some very suggestive observations which they have made upon the subject.[7]

In the year 1879 Mr. F. D. Adams made the important discovery that the scapolites, as a rule, contain chlorine, though in very variable proportions.[8]

Subsequent analyses have fully confirmed this interesting conclusion; and in 1883 Tschermak, in his important monograph on "Die Skapo-

---

[1] *Bull. Soc. Min. Fr.* Vol. II. 1879, p. 113.
[2] *Geol. Fören. i Stockholm Förh.* Bd. VI. (1883) pp. 447-498.
[3] *Geol. Fören. i Stock. Förh.* VII. p. 293.
[4] *Bull. Soc. Min. Fr.* Tome X. (1887) p. 288.
[5] *Brit. Ass. R.* 1884 (Montreal), Proc. of Sect. p. 717.
[6] *Trans. Roy. Soc. Canada.* Vol. V. (1867), Sect. 3, p. 55.
[7] *Canadian Record of Science.* Vol. III. (1888), p. 185.
[8] *Am. Journ. of Sc.* 3rd Ser. Vol. XVII. (1879) pp. 315-320.

lithreihe,"[1] has shown that it is only possible to explain the remarkably discrepant results obtained by the analysis of different members of the group by assuming that the scapolites—like the felspars—must consist of mixtures, in varying proportions, of two isomorphous molecules. The Meionite molecule, as defined by Tschermak, is a basic lime-alumina silicate, and the Marialite molecule is an acid soda-alumina silicate combined with a definite proportion of sodic chloride.

In spite of the protests of Rammelsberg,[2] this view of Tschermak concerning the constitution of the scapolites has steadily gained ground, and now seems to be very generally accepted by mineralogists.

With respect to the nature of the scapolite in the interesting rock of Oedegaarden, it may be sufficient to cite the following analyses:—

	A.	B.
Silica	59·66	54·00
Alumina...	22·65	24·13
Lime	7·32	7·89
Magnesia	2·60	0·95
Soda	8·13	11·81
Potash	feeble traces	—
Phosphorus	sensible traces	—
Loss by Calcination ...	—	1·22
	100·36	100·00

A is an analysis by M. Michel-Lévy of material which had lost volatile matter by fusion, the exact amount not being ascertained, but being certainly less than 2 per cent. By long ignition the mineral was found to lose from 2 to 2·2 per cent.

B is an analysis by M. Wenghell, of the University of Christiania.

As the oxygen ratios of the mineral are 1 : 2 : 6, both MM. Michel-Lévy and Sjögren are inclined to group this scapolite with the dipyres.

By a comparison of the analyses of this and similar dipyres with those of a felspar between labradorite and andesine, it will be seen that the main chemical change required to convert the latter into the former is the introduction of a certain proportion of sodium and chlorine. I propose to show how the introduction of these elements has been effected in the case in question.

---

[1] *Sitzb. d. k. Akad. d. Wissensch. zu Wien.* Bd. 88. I. Abth. (1883) p. 1142.

[2] *Zeitschr. d. deutsch. geol. Gesellsch.* Bd. XXXVI. (1884) p. 120. *Neues Jahrb. für Min. &c.* Bd. II. (1884) p. 67.

The study of a number of slices cut from the series of specimens supplied to me by Mr. Eger, shows that in some cases portions of crystals of felspar—probably the centres of large porphyritic individuals—remain tolerably unaltered in the midst of the rock; while in other cases every phase of the change from felspar to scapolite may be followed step by step.

The felspar, where freshest, presents all the optical characters of a plagioclase; and exhibits repeated twinning, both on the albite and pericline types (Plate IX. Fig. 1). But when viewed by ordinary light the crystals of felspar are seen to present a somewhat dark tint (Plate IX. Fig. 2), and with high powers the cause of this peculiarity becomes at once apparent. It is evidently due to a vast number of minute enclosures within the felspar-crystals (Plate IX. Figs. 3, 4).

A careful study of these enclosures with high powers shows that they are liquid-cavities containing bubbles, and these cavities are found to be crowded together in such enormous numbers, that in some cases they must bear a very considerable proportion to the volume of the mineral in which they are included. These cavities are of especial interest on three grounds.

First. Their distribution in the crystal has clearly been determined by a pre-existent twin-structure in the crystals in which they are developed. This is shown by the fact that wherever any of the lamellæ of either the albite- or pericline-twins appear, their place in the crystal is exactly indicated by great numbers of liquid cavities arranged along the planes which bound the lamellæ. (Compare Figs. 1 and 2, Plate IX.)

If the crystal be viewed alternately by ordinary and by polarised light, it will be seen that these planes marked by crowds of liquid-cavities *map out very exactly* the twin-lamellation of the crystal. Where one of the twin-lamellæ is interrupted or dies out, there a similar break in the continuity of the sheets of liquid-cavities can be made out. There cannot be any doubt that where twin-planes have been developed in the felspar-crystal these have become planes of chemical weakness or instability, and along these solution of the substance of the crystal has taken place, leading to the formation of cavities filled with the solvent.[1] In just the same way I have shown that the kaolinisation of felspars may take place along the planes produced by secondary-twinning of a felspar.[2] The kaolinisation of felspars along certain planes has often been asserted to be due to the solvent action following planes of cleavage. But it is only necessary to examine certain sections by ordinary and by polarised light to see that the

[1] Compare the case of Calcite described in *Min. Mag.* Vol. VII. (1887), p. 87.

[2] *Loc. cit.* p. 89.

partial, interrupted and bent lamellation in a plagioclase felspar is—as in the case now described—exactly mapped out by the bands along which kaolinisation has taken place. (See Plate IX. Figs. 6 and 7.)

Secondly. While the cavities arranged along these planes differ greatly in form and size, there is a very general disposition among them to assume forms bounded by planes, thus constituting negative crystals. In these cases, the broadest and best-developed planes of the negative crystals are usually parallel to those in which the cavities lie—the solution planes. There is thus the closest analogy between these negative crystals in the felspar of the Oedegaarden-rock and those which are formed in the avanturine varieties of a labradorite-felspar which I described on a previous occasion.[1]

Thirdly.—In some of the largest cavities it can be perceived that, besides the bubble, there are crystals floating about in the liquid, and in certain cases these crystals can be seen to be of cubical form. That the liquids in these cavities are supersaturated solutions of the alkaline chlorides is thus shown to be in the highest degree probable; and this probability has been converted into certainty by the following experiment:—Portions of a specimen of the rock, containing these felspar-crystals with inclusions were, after careful washing with distilled water, crushed in an agate mortar and lixiviated; the presence of chlorides in the liquid thus obtained was at once shown on adding silver-nitrate.

In their interesting study of the Canadian scapolite-rocks already referred to,[2] Messrs. Adams and Lawson direct attention to three very important features, which I have also found to be equally exhibited in the Norwegian rock.

First.—Some of the grains of scapolite show traces of a lamellar twinning like that of the felspar-crystals from which they are derived,[3] though the extinction was found to be much less distinct than in the felspar.

Secondly.—In many of the grains of scapolite numerous enclosures arranged in parallel bands occur.

Thirdly.—While some of the grains of scapolite exhibit the strong double refraction characteristic of that mineral, and polarise in brilliant

---

[1] *Min. Mag.* Vol. VII. (1886), pp. 85-87. Plate III. fig. 3. See also Vogelsang in *Archives Néerlandaises.* Vol. II. (1868).

[2] *The Canadian Record of Science* 1889.

[3] *Loc. cit.* p. 193.

[4] *Loc. cit.* p. 194.

tints, others lying side by side with them display only low polarisation tints, little more pronounced, indeed, than those of felspar. That the difference is not due to thickness is shown by the fact that grains with strong and weak double refraction are seen lying side by side in the same section.[1]

The authors very justly insist on the support afforded by these phenomena to the conclusion that the scapolite has been produced by the alteration of a plagioclase-felspar, and that in some cases the change is incomplete.

The study of the Norwegian rock proves, I think conclusively, not only that this is the case, but enables us to realise the several stages of the process by which the transformation from one mineral species to another is effected.

In the least altered felspar-crystals the partial and irregular distribution of the lamellar twinning may be noticed, and is strongly suggestive of its having been developed by mechanical forces. The development of cavities, many of them of the nature of negative crystals, disposed along the gliding planes, is clearly due to the fact that these twin-planes have become planes of chemical weakness. If dark-coloured, secondary products had been deposited in these negative crystals and other cavities, then a perfect "schiller" structure would have been developed like that characteristic of diallage, bronzite, and certain felspars.

That the solvent—which, under statical pressure, permeated the whole substance of the felspar-crystals and attacked them in their planes of chemical weakness—was a solution containing sodic chloride we have the clearest proof; and the problem which remains to be considered is the nature and origin of the chemical reactions by which the sodic chloride in the cavities became combined with the silicates of the felspar in which they were enclosed, so as to give rise to the formation of a scapolite.

In some cases I have found large crystals of felspar, with numerous liquid cavities developed in them, the outer portions of which have been converted into scapolite granules. Some of these granules have the characteristic double refraction of scapolite; but in other cases, while all the other optical properties are those of scapolite, the polarisation tints are but little higher than those of the adjoining felspar.[2] In a few instances but little granulation has accompanied the formation of the scapolite—

[1] *Loc. cit.* p. 193.

[2] It is worthy of note that MM. Michel Lévy and Lacroix have found that there are great variations both in the refraction and double refraction of the different mixtures of the meionite and marialite molecules (*Les Minéraux des Roches* 1888, p. 293).

which in these cases forms broad crystalline masses replacing parts of the felspar-crystals.

In not a few cases we find the outside of the secondary granules of scapolite quite free from enclosures, while in the middle of them there are many liquid cavities, evidently those belonging to the original felspars. (See Plate IX. Fig. 5.) It is worthy of notice that the polarisation tints of the outer portions of these grains, where all trace of the cavities has disappeared, is markedly higher than those of the interior portions where the cavities still exist. The complete conversion of the felspar into scapolite appears to be attended with the disappearance of the liquid cavities.

In many cases grains, which must be referred to scapolite, exhibit more or less distinct traces of the twinning of the original felspar; that this is the true interpretation of the phenomenon is proved by the fact that in the Oedegaarden rock the traces of twin-lamellæ in the peripheral scapolite granules can be seen to be *actually continuous with or parallel to* those in the unaltered central mass of felspar. (See Plate IX. Fig. 1.)

With all these facts before us, I think that it is impossible to doubt that the formation of the scapolite-molecules at the expense of those of felspar by the addition of the sodic chloride, is one that goes on progressively in the crystals, and that we have crystalline particles in the rock which consist in varying proportions of the felspar- and the scapolite-molecules.

In his interesting investigations upon Tabasheer, Sir David Brewster long ago showed that it was possible to have such an intimate admixture of colloid silica and of air, that the resulting material possesses an index of refraction intermediate between those of the two substances in question.[1] The study of the mineral constituents of rocks often affords similar illustrations of the ultramicroscopical admixture of substances with different optical properties.

In the paramorphic and pseudomorphic changes which take place in the minerals of rocks we find many beautiful illustrations of the same kind. Tschermak's valuable researches on the felspars, the scapolites, the pyroxenes, the amphiboles and other groups of minerals have shown the possibility of the existence, with the same crystalline form, of mixtures in very varying proportions of two or more molecules of different chemical constitution. The gradual conversion of pyroxenes into amphiboles, by the process of uralitisation, and the development of certain minerals at the expense of others, during contact metamorphism, may

[1] *Phil. Trans.* Vol. CIX. (1819), p. 283; and *Edinb. Journ. of Science*, Vol. VIII. 1828), p. 335.

prepare us for examples of the transformation of one species of mineral into another, by the progressive change of its component molecules.

We now come to the question of the *cause* of the breaking up of the felspar-molecules, and the formation from them and the sodic chloride of the scapolite-molecules.

The scapolite-rock of Oedegaarden exhibits, in hand specimens, but little evidence of distinct foliation. That it has been subjected to a certain amount of internal movement is, however, indicated by the granular character which it assumes. I have already shown that crystals of augite in ophitic dolerites become broken up into rounded granules when the rocks in which they were being found were subjected to internal movements during crystallisation; and that the rocks thus assume the granulitic structure;[1] and this observation has been confirmed by Dr. Hatch.[2]

All the evidence with respect to the Oedegaarden rock points to the conclusion that, after the felspar-crystals had become charged, along their solution-planes, with cavities containing sodic chloride the effect of internal stresses in the rock-mass was to bring about those chemical reactions by which the felspar-molecules were broken up and their materials became united with the sodic chloride to form scapolite. I find additional evidence of the action of dynamometamorphism in the gabbros of the same district, where the scapolite-rock is developed. In these gabbros the constituent minerals are all found to be surrounded by concentric zones of various secondary minerals—like those of the "flaser gabbros"—and the results of the dynamometamorphic action in these rocks appear to be worthy of very careful study. Most of the occurrences of scapolite, which have been described, are in rocks of gneissic character.

The scapolite which is found in the specimens of the Oedegaarden rock where the felspar has not altogether disappeared, is sometimes remarkable for its freshness and its almost perfectly unaltered character. One of the most striking features it not unfrequently presents is the total absence of cleavage-cracks. This character, with its wonderful clearness and fresh appearance, gives it a most deceptive resemblance to quartz. I suspect that, on account of this resemblance of the two minerals, scapolite has often been overlooked in rocks where it occurs. While the presence of characteristic cleavage-cracks is a valuable means of diagnosis in the hands of the petrographer, their absence is a character upon which we ought always to hesitate to found conclusions. Many highly cleavable minerals may, under

[1] *Quart. Journ. Geol. Soc.* Vol. XLII. (1886), p. 76.

[2] *Trans. Roy. Soc. Edinb.* Vol. XXXV. (1888), Part 2, p. 104.

certain circumstances, fail to show the accidental cleavage-cracks upon which we ordinarily depend in our rock-sections.

It is very interesting to note that the other principal constituent of the Oedegaarden rock—the pyroxene—can be shown, during its conversion into hornblende, to have gone through a precisely parallel series of changes to those which the felspar was subjected to in passing into scapolite.

The original pyroxene of the rock appears, from portions which remain unaltered in some of the specimens, to have been a nearly colourless variety. The straight extinction, the pleochroism and the feeble double refraction of all the specimens I have been able to examine indicates that it was a rhombic pyroxene or enstatite. In almost all cases, however, the development of enclosures parallel to a pinacoidal plane has converted it into a schillerized variety—in this case bronzite.

This pale coloured bronzite is in places found acquiring the characteristic colour, pleochroism and absorption of a brown hornblende; but in these cases this pleochroism and absorption are decidedly feeble, and it is worthy of notice that the characteristic bands of enclosures belonging to the bronzite remain; nevertheless, though the cleavage still appears to be that of a pyroxene rather than of a hornblende, the extinction and double refraction are unmistakably those of an amphibole.

In the conversion of the enstatite into hornblende, the relations of the orthorhombic and monoclinic crystals are the same as is found in the intergrowths of orthorhombic and monoclinic pyroxenes; the central portion of the crystal consisting of enstatite has its macropinacoid (100) parallel to the clinopinacoid (010) of the zone of secondary hornblende which surrounds it.

In the case of many other rocks, I have met with examples of a pyroxene which has acquired the colour and pleochroism of a hornblende while retaining some of its original characteristics.

Thus in an ophitic dolerite from the Shiant Isles, and in a dolerite from a dyke at Assynt, I have found pyroxene-crystals which retain the cleavage and extinction of that mineral, but which are seen to acquire progressively, as we approach their edges, the characteristic colour, pleochroism and absorption of a brown hornblende. The pyroxenes of the rock of Penmaenmawr which, when unaltered, were shown by Rosenbusch to be a somewhat ferriferous enstatite,[1] acquire by alteration, as was noticed by the late John Arthur Phillips,[2] the characteristic colour, pleo-

[1] *Massige Gesteine*, 1st Ed. (1887), p. 352.

[2] *Quart. Journ. Geol. Soc.* Vol. XXXIII. (1877), p. 423.

chroism and absorption of hornblende, while retaining the orthorhombic extinction. The same is true of the pyroxenes of the Eycott-Hill rock, and many similar cases might be mentioned.

The last stage of the change of the pyroxene in the Oedegaarden rock is witnessed in the case of certain crystals which, around their edges and in irregular patches in their midst, exhibit a development of the fully pronounced pleochroism, and absorption, together with the very characteristic cleavage of hornblende. The existence of two types of hornblende—the one with feeble pleochroism and absorption, and the other with very intense pleochroism and absorption—has already been noticed by Sjögren in this rock. The last stage of the change into hornblende appears to be always accompanied by a remarkable "granulation" of the crystals. The original pyroxenes crystallise in broad and thick plates, but these, before acquiring the fully pronounced characters belonging to hornblende—namely, the strong pleochroism and absorption as well as the cleavage—in all cases break up into a mosaic of more or less rounded granules—each individual granule presenting its own peculiar orientation. It may be remarked that many rock-forming amphiboles and micas undergo great changes in their pleochroism and absorption and these changes may affect the whole or, as in the formation of pleochroic halos and similar phenomena, only portions of the crystals.

While the original pyroxene-felspar-rock appears to have a perfectly *granitic* structure, the derived hornblende-scapolite-rock has a most marked *granulitic* structure. The large felspar-crystals become an aggregate of scapolite-granules; and the large pyroxene-crystals break up into a similar mosaic of hornblende-granules.

Nothing can be more striking than the parallelism of the changes undergone by the two chief constituents of this very interesting rock; and nowhere perhaps can we find more instructive illustrations of the effects produced, in the first place, as the results of chemical action resulting from statical pressures (schillerization), and in the second place, from the changes induced by the internal stresses set up in a rock during its deformation in the act of flowing (dynamometamorphism).

The effect of the statical pressure is seen in the way in which the crystals of felspar and pyroxene, respectively, yield to the solvents—which under the enormous pressure must permeate their whole substance—this solvent action taking place where planes of chemical weakness or instability exist in the crystal. In the case of the felspar-crystals, cavities, often assuming the forms of negative crystals and containing liquids, arise; in the

case of the pyroxenes, these cavities become filled with various secondary solid products, which, having a submetallic lustre, give rise to the schiller of bronzite.

In the case of the pyroxene it is found that there is a marked tendency of the crystals, while retaining the characteristic cleavage, enclosures and other properties of bronzite, to acquire the extinction and double refraction, and *to a limited extent* the colour, the pleochroism, and the absorption of hornblende.

The last change is a very striking and instructive one. In the bronzite, and in the felspar (with its cavities containing a solution of sodic chloride), we have the necessary materials for forming a hornblende and a scapolite respectively—the former by a paramorphic the latter by a pseudomorphic change.

These final results seem to be clearly referable to dynamometamorphic action—and are in each case accompanied by that *granulation* of the mass which is the result of crystalline forces acting on materials that are at the same time subjected to powerful mechanical stresses. The "granulation" of the hornblende and the scapolite respectively cannot, it appears to me, be regarded as simply a mechanical crushing of the crystals—as some writers on metamorphism seem to have imagined—but must be referred to a crystallising process going on *under the influence and control of powerful mechanical stresses*.

Such appear to be the series of processes by which a perfectly GRANITIC rock, composed of *pyroxene* and *felspar*, is converted into a remarkably GRANULITIC rock made up of *hornblende* and *scapolite*.

We have, it seems to me, the most complete evidence that, alike in the conversion of enstatite into hornblende, and in the transformation of felspar into scapolite, the change takes place slowly, molecule by molecule, and the distinctive properties of the new crystalline substance are acquired gradually and by successive stages, some of which it is possible to trace.

The investigation of the nature, the relations, and the sequences of those changes which take place in the distinctive properties of a mineral—as it is gradually transformed into another species—and the determination of the causes to which these changes must be severally assigned, are problems which may worthily engage, as they will certainly demand and reward, the combined efforts of the geologist and the mineralogist.

EXPLANATION OF PLATE IX.

Alteration of Plagioclase Felspar.

Fig. 1. Crystal of plagioclase-felspar seen between crossed nicols, magnified 25 diameters. The central portion exhibits the twinning (on both the albite and pericline types), the refraction, double refraction, extinction and other characters belonging to plagioclase-felspar. The outer part of the crystal consists of a number of large grains of scapolite, in some of which a faint indication of the lamellar structure of the felspar can still be detected, though the extinction of these is never definite as it is in the felspar. In the part marked *x* we have a grain exhibiting all the optical properties of scapolite, but in which lamellæ that do not give definite extinctions can be detected,—and these lamellæ are evidently parallel to those in the unaltered felspar. Outside of these again we find a mass of scapolite-granules, some exhibiting low and others high polarisation-tints.

Fig. 2. The crystal seen with the same magnifying power by ordinary light. The felspar is seen to be traversed by bands of cavities, which are so numerous as to give the mass a dark colour. That these bands of cavities exactly map out the lamellæ of the albite- and pericline-twins becomes very obvious, if we examine the crystal alternately by ordinary and polarised light.

(A series of examples may be selected from the rock, showing felspars almost unaltered, others with narrow zones of scapolite around them, and others in which the zones of scapolite have increased till only a vestige of the original felspar remains in the centre.)

Fig. 3 shows a portion of this felspar-crystal, with its numerous inclusions, as seen with a magnifying power of 250 diameters. The development of these cavities along certain definite planes, and their tendency to assume the form of negative crystals, with their most largely developed planes parallel to planes of chemical weakness, is very clearly indicated.

Fig. 4. Cavities of the same felspar-crystal as seen with a magnifying power of 2500 diameters.

a. Large irregular liquid cavity with a bubble and two small cubic crystals.

b. Flat-sided cavity (negative crystal) with a bubble.

c. Similar cavity in which no bubble is seen.

Fig. 5. Group of granules of scapolite as seen magnified 100 diameters. In the centres of these granules are seen groups of cavities arranged in

lines, like those of the felspar-crystals, from which the scapolite has been derived. By polarised light it may often be observed that the centres of the granules containing the cavities polarise in lower tints than the exterior margins which are free from cavities.

Figs. 6 and 7. Two views of a plagioclase-crystal from a diorite, Old Meldrum, Aberdeenshire, magnified 100 diameters.

Fig. 6 shows the crystal as seen with crossed nicols. The two systems of twin-lamellæ—the one system only very partially developed, and the other system exhibiting very marked curvature, are very distinctly displayed.

Fig. 7 shows the same crystal viewed by ordinary light. The kaolinisation of the felspar is seen to have been determined by the presence of the twin-lamellæ—the curvature of the one system, and the partial character of the other system being very conspicuous. In this and other similar cases, the lines of secondary inclusions or of kaolinisation, as seen by ordinary light, completely map out the twin-lamellation as seen by polarised light. It is only necessary to examine the section alternately by ordinary and by polarised light, to perceive how complete is the correspondence between the twin-structures and the planes of chemical instability in the crystal.

On the Occurrence of Gyrolite in India.

By Prof. M. Forster Heddle, F.R.S.E.

[Read March 12th, 1889.]

SOME little time ago I observed very large and fine specimens of *gyrolite* among a number of zeolites which a friend had lately received as a gift, from the cuttings on the railway from Bombay to Poonah—the locality for the fine apophyllites. These occurred in specimens much larger than those in which the mineral is seen in Iceland, Faröe, or Scotland.

The foliæ were disposed in reniform groupings of quite an inch in thickness, and were covered by a thin layer of apparently a white saponite. No crystal was seen, and from the general solidity of the hemispherical arrangements, there seemed to be but little hope of free crystals occurring at the locality.

The mineral is somewhat more greasy looking, *i.e.* less pearly than the Scotch specimens, but this may be due to the near presence of the saponite.

Never having observed any notice of gyrolite from this locality, it may be well to put it upon record.

On Dudgeonite, Hydroplumbite, Plumbonacrite, and Plattnerite.

By Professor M. Forster Heddle, F.R.S.E.

[Read March 12th, 1889.]

Dudgeonite.

THIS substance was found by Mr. Dudgeon at the Pibble mine, which is directly opposite to Cairnsmore of Fleet, in Kirkcudbrightshire, and is within a few miles of Creetown.

This mine was worked for lead, and a few pieces of copper-nickel (nickeline) were obtained at it. The blue variety of the silicate of zinc also very sparingly occurred, and there were slight appearances of the phosphate and of the carbonate of lead.

The specimens of copper-nickel had very rough corroded-looking surfaces, with pitted cavities, which were filled with the substance analysed.

This is a greyish-white, loose-structured solid, which is easily powdered. Some small spots of some of the specimens were tinged pale pink, and others pale green; but there was no definite appearance of either annabergite or of pharmacolite. It is usually dull, but here and there has a slight resinous lustre. From its absorbing water the specific gravity could not be determined. H. about 3 or 3·5. Fracture, earthy. Streak, lustrous or waxy.

In closed tube gives off water, and becomes slightly grey. B.B. fuses imperfectly to a lustrous slag. On charcoal gives off arsenical fumes, and forms a scoriaceous mass which shows pellets of metal. Totally soluble in nitric and in chlor-hydric acids; not entirely soluble in sulphuric acid.

The analysis was executed upon 10·97 grains, picked under a magnifier.

Oxide of Nickel	25·01
,, Cobalt	·76
Lime	9·32
Arsenic Acid	39·33
Water	25·01
	99·43

The calculations for the formula are—

NiO	... 25·77 ÷	37·5 =	·687 = 2 =	75 =	25·862
CaO	... 9·32 ÷	28· =	·333 = 1 =	28 =	9·655
As_2O_5	... 39·33 ÷	115· =	·343 = 1 =	115 =	39·655
H_2O	... 25·01 ÷	9· =	2·777 = 8 =	72 =	24·828
				290	100·000

Formula $(\frac{2}{3}\ NiO + \frac{1}{3}\ CaO)_3\ As_2O_5 + 8\ H_2O$

Annabergite, with one-third of the nickel oxide replaced by lime. This is somewhat near Forbesite (Dana p. 560).

I have much pleasure in naming this substance—as is most fit—after its discoverer.

Hydroplumbite and Plumbonacrite.

About the year 1853 Mr. Greg sent me for examination the substance now to be—though only very partially—described. He wrote that the locality given for it was Cumberland, but he appeared to be in some doubt as to the accuracy of this. He considered the probability more in favour of Leadhills, and the specimen certainly has more the appearance of a Leadhill specimen than it has of any I have seen from Cumberland. The bulk of the specimen is cerussite upon galena; yellow pyromorphite overlies, with a group of caledonite crystals in one corner.

The substance to be described overlies all the others, and is lodged in largest amount in cavities of the pyromorphite.

It is in very minute scaly crystals, which unite to form thin flakes. These have an exceedingly high pearly lustre. They are of the purest white. They appear to be hexagonal.

The chemical and blowpipe characters are most marked.

The flakes are *entirely* soluble, *without the slightest effervescence*, in nitric acid. The solution gives the reactions for lead, but for no other metal.

B. B. in closed tube gives out *much* water, and *instantly* becomes *bright red*. Upon a slight increase of heat unites with the glass, and forms a *clear transparent* glass therewith.

As the quantity altogether was insufficient for a quantitative analysis, a small portion was left upon the specimen, and it was retained in the hope of others being obtained.

Steps were at once taken to endeavour to *form* such a compound as this appeared to be.

A quantity of a solution of acetate of lead was precipitated by ammonia. The precipitate was washed with warm thrice-distilled water, and was set aside in an absolutely-full bottle of recently distilled water, being left for a number of years.

Scale-like crystals gradually formed upon the surface, and throughout the mass of the "claggy" precipitate. Through the solution of these during summer, and the re-growth of the larger ones during winter (according to the usual law), these crystals gradually increased in size.

When examined these crystals behaved both chemically and B.B. precisely as did the above mineral; but they appear to belong to the prismatic system, and are biaxal. The quantity of water obtained from them left no doubt that they were $3PbO, H_2O$; and, notwithstanding the apparent difference in the symmetry, the mineral in all probability has the same composition; from this composition I would propose for it the name *hydroplumbite*.

In 1857 I was presented by my late colleague, Dr. Macdonald, with a specimen of leadhillite with susannite in very large crystals, which had a little of apparently the same substance as the above upon it. The colour was, however, slightly greyish, or at least not so purely white. Still I should have said that they were the same.

This also gave out water in the tube. It dissolved *totally* in nitric acid, but *with* effervescence.

B.B. in closed tube, after emission of some water, it became a *yellow* blebby mass, which united with the glass with difficulty, forming a *dull yellowish* compound.

The two are therefore different; and *neither* can be leadhillite.

In 1878 and in 1880 I got several small specimens from Dr. Wilson of Wanlockhead, which carried a good deal of the *second* of these substances, and apparently pure.

No larger quantity being procurable after considerable delay, I was forced to make the quantitative examination of this "Hydrocerussite"[1] upon only 3·96 grains for the lead and water, and upon 4·32 grains for the carbonic acid and lead.

There was obtained :—

	1.	2.	Average.
Lead oxide ...	92·617	93·08	92·848
Water	2·008		2·008
Carbonic Acid ...		4·764	4·764
Insoluble		·78	·78
			100·400

[1] A. Lacroix. *Bulletin de la Société Minéralogique de France*. Bull. No. 2. Nordenskiöld, in *Geologiska Foreningens de Stockholm*, Vol. III. No. 12, Mai 1887, describes a similar Hydrocerussite from Longban in Sweden. This M. Bertrand—*Bull. Soc. Min.* T. IV. 1881, p. 87, finds to be *uniaxal*. None of these Hydrocerussites have, I believe, been analysed. The Wanlockhead mineral Lacroix finds to be uniaxal, and apparently hexagonal.

92·617	÷	111·5	= ·831 =	4	×	111·5	= 446 =	93·501
4·764	÷	22·	= ·216 =	1	×	22·	= 22 =	4·612
2·008	÷	9·	= ·223 =	1	×	9·	= 9 =	1·887
							477	100·000

Formula $PbO, CO_2 + 3PbO, H_2O$.

Not being a hydrated cerussite, it may be called Plumbonacrite.

This plumbonacrite and the mineral sent by Greg are, to the eye of the writer, it should be stated, indistinguishable in appearance.

Notes on Plattnerite.

1877. Given me some years ago, as probably *wad*, by Dr. Wilson, and as from Belton-Grain Vein, Wanlockhead.

It occurs in the centre of crystalline masses of plumbocalcite, in mammillated masses; these have a structure which is a combination of concentric layers, with a rude rhomboidal fracture or cleavage. The angle of the cleavage faces is about 104°.

The colour is brown, the lustre dull; it marks the fingers, and is softer than calcite. Its specific gravity varies between 8·8 and 8·96.

It yielded a varying quantity of carbonate of lime; one specimen as much as nearly 3 per cent. Traces of arsenic acid, vanadic acid, and phosphoric acid were found; the remainder being only oxide of lead.

1882. Purchased in Leadhills.

Occurs as very singular single and confluent mammillated nodules, along with, perhaps superimposed upon, smithsonite.

This leads to the belief that the specimen was got in the Bay Vein.

The nodules are smooth in their central portions; but these are set round with concentric rings of corrugated or rough rings.

The central portions are brilliantly smooth and black; the rings are rough and black.

The lustre of the fracture, which is conchoidal, is vitreous; and, the colour of a fractured surface being somewhat brown, the appearance is like that of pitch. The specific gravity is 9·27. Not being willing to sacrifice so rare a specimen, a qualitative examination was alone made. Oxide of lead with traces of vanadium were alone found.

Mineralogical Notes.

Polybasite; Aikinite; Quartz; Cuprite; The Locality of Turnerite.

By H. A. Miers, M.A., &c.

[Read March 12th, 1889.]

Polybasite.

THIS mineral occurs in thin hexagonal plates with bevilled edges, which were formerly referred to the rhombohedral system, on account of their characteristic triangular striations, which run parallel to alternate edges of the hexagon.

Des Cloizeaux in 1867 (*Nouvelles Recherches*, p. 85) found the crystals from Freiberg, which are sometimes sufficiently thin to transmit light, to be biaxal, the acute bisectrix being perpendicular to the surface of the plates; the apparent angle between the axes could not be determined accurately, but was found to vary from 63° to 88°. The mineral must consequently be regarded as orthorhombic, with a prism angle very near to 60°. The only crystallographic measurements which have been published relating to polybasite are those of Breithaupt, who found the minute planes which bevil the edges of the plates to be inclined at 58°30′ to the basal plane (*Vollständige Charakteristik des Mineralsystems*, 1832, p. 266); in accordance with this measurement the mineral has always been referred to a rhombic pyramid, having the angles 50°28′ and 95°12′.

An accurate determination of the form is difficult, both on account of the small size of the pyramid faces, and because the crystals are almost invariably composed of a number of triangular or hexagonal plates piled together in nearly parallel positions.

The following elements are deduced from the best measurements obtainable on 15 crystals from Andreasberg, Freiberg, Przibram, Guanaxuato and Caldera (Chili), and may be regarded as correct to a close degree of approximation; it will be seen that they do not agree in the least with the measurements of Breithaupt.

System orthorhombic.

$$a : b : c = 1{\cdot}7262 : 1 : 0{\cdot}6344$$

$100 : 110 = 59°55′$; $010 : 011 : = 57°36\frac{1}{2}′$; $001 : 10\bar{1} = 42°24′$

Forms observed.

c	001	0P	*w*	109	$\frac{1}{3}\breve{P}\infty$
m	110	∞P	*p*	111	P
n	101	$\breve{P}\infty$	*s*	221	2 P
t	201	2 $\breve{P}\infty$	*r*	112	$\frac{1}{2}$ P

	Observed.	Calculated.	No. of Edges.	Limits.
	° ′			° ′ ° ′
cp	61·14		8	61·5 – 61·24
mm	60·10		1	
cn / *cr*	41·57	42·24 / 42·19½	23	40·48 – 42·30
ct	61·14	61·18	3	61·8 – 61·17
cs	74·53	74·39	6	73·55 – 75·50
cw	5·40	5·48	1	

The prism angle *mm* could only be determined with accuracy by one direct measurement; but the angles between three consecutive pyramid zones were found by the cross measurements, $rn = 52°8'$, $pt = 71°46'$, to be 60°10′ and 60°11′ respectively, upon one very good crystal from Caldera, which yielded the following angles in the same zones:—

$cp = 61°14'$	$cs = 74°3'$
$cr = 42°12'$	$cm = 90°17'$

It is not possible to distinguish between the faces *n* and *r*, nor with certainty between *p* and *t*, since the three vertical zones formed by the base with the bevilling planes are nearly identical.

It is almost certain, however, that the only faces perpendicular to the base are those of the prism {110}, and that *s* is invariably associated with these, whereas the brachydiagonal zone *c n t* does not contain faces of the brachypinakoid {100}.

Those crystals (by no means rare) which apparently possess six faces belonging to a hexagonal prism, are to be explained by the overlapping of plates in twin position, the twin plane being (110).

That polybasite is twinned according to this law is proved by the optical character of the flakes from Caldera, which do not become dark in any position between crossed nicols, and rarely give a definite interference figure; the optic axes when discernible lie in planes inclined to one another at 60° in various parts of the same plate, proving that there is both a juxtaposition and an overlapping of twinned plates. The plane

of the optic axes is, as was stated by Des Cloizeaux, the macropinakoid (010).

Note.—In the Manuscript Catalogue of the Allan-Greg Collection, which now forms part of that of the British Museum, Haidinger gives 61° and 42° as the inclinations of the two faces to the basal plane, and the above table shows that these angles are nearly correct.

Aikinite.

The only measurement previously recorded for Aikinite (Patrinite, Nadelerz), is a prism angle of 70° given by Hörnes in *Haidinger's Berichte*, ii. (1847) p. 249.

The needles which are embedded in quartz and have no terminations are very difficult of measurement on account of their ribbed and striated character, and also because it is not easy to extract them from the quartz without fracture.

The examination of 18 crystals from Beresovsk has led to the conclusion that they are orthorhombic, and that the prism angle is 88°22′.

Calling this prism {110}, the measurements indicated further the presence of the prisms {310}, {210}, {140}, among the striated faces; the corresponding angles being—

	Observed.	Calculated.
100 : 310	19°·4	18°·56
100 : 210	26·34	27·13
100 : 140	63·26	62·47

These observations (which are merely approximate) were made partly upon crystal fragments and partly upon the impressions of needles in the quartz, which have a much brighter surface than the needles themselves.

The prism angle of Bournonite, which has a similar composition, is 86°20′, but it is impossible to say whether, if the two substances are isomorphous, the prism of Aikinite is to be compared with the prism 86°20′, or the macrodome 87°26′, or the brachydome 83°46′ of Bournonite.

Quartz.

A crystal of quartz occurring with apatite, orthoclase, lepidolite and gilbertite from Cornwall, which was kindly lent to me for measurement by Mr. Semmons carries a small face, having the indices $(22 . 5 . \bar{1}1)$, which is one of the rare faces of this mineral, having been only recorded previously by vom Rath, on a crystal from North Carolina, U.S.A.

The crystal is a combination of the forms—

b	$\{2\bar{1}\bar{1}\}$	∞R	s $\{41\bar{2}\}$ $2P2$
r	$\{100\}$	R	x $\{4\bar{1}\bar{2}\}$ $4R\frac{3}{2} = 6P\frac{6}{5}$
z	$\{22\bar{1}\}$	$-R$	x_1 $\{22 . 5 . \bar{11}\}$ $\frac{7}{2}R\frac{11}{7} = \frac{11}{2}P\frac{11}{5}$

and is left-handed.

x_1 is a smooth but small face, replacing the edge between the characteristic rhombic face s and the trapezohedral face x, which generally serve to indicate the right- or left-handed character of a quartz crystal.

	Observed.	Calculated.
zr	46°14′	46°16′
zr	28·54	28·54
zx_1	53·41	53·41½
zx	54·50	54·51

The crystal described by vom Rath (*Zeits. f. Kryst* xii. 454) was also left-handed, and had x_1 replacing the edge between the prism and the face u $\{8\bar{1}\bar{4}\}$ $4P\frac{4}{3}$.

Cuprite.

A crystal from Wheal Phœnix, presenting a combination of the forms {111} {100} {211} {110} was found to have two faces (533) and (322) between the octahedron and the icositetrahedron (211); of these (533) has not been recorded before. The face is smooth, but slightly curved in the zone [211 : 111].

	Observed.	Calculated.
211 : 533	5°24′	5°.2′
211 : 322	8·2	8.3

The Locality of Turnerite.

The locality of the Turnerite from Dauphiné, which was first described by Lévy, in the *Annals of Philosophy*, Vol. XXI. March 3rd, 1823, p. 241, is stated in all the text books to be Mont Sorel.

Lévy himself only speaks of the mineral as occurring "with adularia and lamellary crichtonite from Dauphiny." But the same substance was more completely described by W. Phillips two months later (May 10th, 1823) in his *Elementary Introduction to Mineralogy*, Third Edition, p. 382, where he says, with regard to this locality:—"It has been found only on Mont Sorel, in Dauphiné, accompanying quartz, lamellary crichtonite, and the octahedrite."

It appears that all subsequent writers have taken the locality from this statement of Phillips.

Three years ago, however, Mr. Seligmann, of Coblenz, informed me that in a tour through Dauphiné, which he made in company with Prof. Groth in the year 1882, no trace of a mountain bearing this name could be found; and he asked me if I knew from what source Phillips had derived his information regarding the locality.

The results of Groth and Seligmann's tour through Dauphiné are to be found in a paper by the former, entitled "Die Minerallagerstätten des Dauphiné," in the *Sitzungsber. der Königl. bayer. Akad. der Wissenschaften zu München*, xv. (1885) p. 371.

From that description there appears to be no doubt that the true locality of the Turnerite to be found in most mineral collections is Le Puys, near St. Christophe, where it occurs associated with albite, quartz, chlorite, dolomite, crichtonite, pyrites, sphene, brookite and anatase; it is also found with albite, quartz, anatase, calcite, pyrites, and chlorite at the neighbouring locality of le Fremey in the Romanche Valley.

As the possible origin of Mont Sorel, Groth is only able to refer to the Alp Sarrel, which is close to Maronne. The only other mineral, apparently, which is recorded from Mont Sorel in Dauphiné is the Epidote mentioned by Bücking (*Zeitschr. f. Kryst.* Vol. II. p. 401).

In order that the existence of this fabulous mountain may be completely disproved, it becomes necessary to discover how Phillips obtained the locality of his specimen.

Lévy mentions that at the time when he was writing, the new mineral was very scarce, and "besides the specimen where I have observed it Mr. Heuland knows but one more, in England." Phillips, however, writing two months later, says that it has been "heretofore considered a variety of sphene," and "has occasionally been brought into this country under the name of Pictite."

The last sentence proves to be the key to the mystery. Pictite was the name given by Delamétherie (*Leçons de Minéralogie*, i. (1812) p. 331) to certain crystals found by Prof. Pictet at Chamounix. Now similar crystals from Binden were the subject of a memoir by F. Soret, of Geneva (in the year immediately preceding the discovery of Turnerite), in which the author advances reasons for regarding Pictite as a distinct species. This mineral has been subsequently recognised as identical with sphene.

It appears, from what Phillips says, that Turnerite was at first supposed to be Pictite; what then can be more natural than that Mont Sorel is in some way a corruption of Mons. Soret?

It is possible, for instance, that specimens of the newly found mineral from Dauphiné being regarded as identical with the Pictite recently described by Soret were labelled

Pictite de Mons. Soret,
Dauphiné,

and that such a label was read erroneously, or copied as

Pictite de Mont Sorel,
Dauphiné.

The next step, then, is to trace the specimen described by Phillips, and see whether there is any indication of such an error.

Now Phillips' collection was sold in 1829 to Dr. Rutter, of Liverpool, and in the "Catalogue of a Cabinet of Minerals, the property of the late W. Phillips, now to be disposed of by private contract," 1829, p. 44, the following entry is to be found:—

"Pictite with blue anatase, chloritous quartz and adularia, Mont Soret, Dauphiny."

If, then, this entry is correctly reprinted from the label of the specimen, the spelling of the word Soret supplies the indication which we seek; it only remains to compare the entry with the original label.

The collection was bequeathed by Dr. Rutter to the Medical Institution of Liverpool, whence it was transferred in 1877 to the Liverpool Museum; I accordingly wrote to Mr. T. J. Moore, the Curator, who at once caused search to be made, and found both the specimen and the written label, and through his kindness I was enabled to see the latter, and make sure that the locality is there written as "Mt. Soret."

There can be little doubt then that the mountain does not exist, and that it was introduced by a clerical error into mineralogical literature in which it has enjoyed a fictitious existence for the last 60 years.

Abstracts.

Canadian Rocks containing Scapolite, and the Canadian Apatite Deposits (F. D. Adams and A. C. Lawson in the *Canadian Record of Science*, pp. 185-201, 1888).—The apatite of Canada occurs in irregular veins with certain pyroxenic rocks not yet thoroughly studied; these veins of apatite and "pyroxenite" are found in connection with mica-syenite and augite-mica-syenite. The scapolite-diorite, which in Norway is so intimately associated with the apatite deposits, does not occupy the same position in Canada; but scapolite-diorite, plagioclase-scapolite-amphibolite, and plagioclase-scapolite-diorite do not occur in the Laurentian rocks in other places, being associated with ordinary amphibolites and crystalline limestones. A. H.

Origin of Ottrelite in the Upper Salmian Rocks of the Ardennes. (*Ann. Soc. Géol. du Nord*, Vol. XV. pp. 185-318, 1888.)—Prof. Gosselet has made an exhaustive study of the mode of occurrence and peculiarities of structure of the ottrelite of the Upper Salmian rocks, all of which contain that mineral in greater or less quantity. The mineral itself has already been sufficiently described by Renard and de la Vallée-Poussin and others. The author finds that the ottrelite has been formed since the rocks assumed the condition of slate, for it encloses all the other constituents, including the rutile, and the rows of hæmatite and ilmenite granules in the rocks pass through the ottrelite crystals. The mineral has been produced at the expense of other constituents, the rock in the immediate neighbourhood of each crystal having been deprived of certain elements to make up the ottrelite. The formation has been accompanied by some molecular movement by which the larger grains of hæmatite and ilmenite have been expelled from the spaces now occupied by ottrelite and formed borders to the crystals. These effects are ascribed by the author to heat, produced generally by mechanical forces. Subsequent disturbances have tended to set the flakes of ottrelite more nearly parallel to the direction of "*longrain*," and the flakes themselves are sometimes broken. Spaces formed by these movements have been filled by quartz and mica in contact with the ottrelite. Besides the crystals of ottrelite are found kernels and globules of the same which, with many other peculiarities, are described in the memoir. An account is also given of the rocks themselves, which are already known by the researches of the author and others. A. H.

E. Cohen. *Goldführende Conglomerat in Südafrika,—Ueber die Entstehung des Seifengoldes.*
Separat-Abdrücke aus den Mittheilungen des naturwissenschaftlichen Vereins für Neuvorpommern und Rügen. 19 Jahrg. 1887.

In the first paper the author describes some specimens of the auriferous conglomerate which occurs on the Witwatersrand, a mountain-chain between Potchefstroom and Pretoria stretching in a westerly direction across the middle portion of the S. Transvaal. The conglomerate is of palaeozoic age, and the gold is found both in the pebbles and the cementing material.

The larger pebbles, which are only about the size of walnuts, have their edges more or less rounded, but are mostly flattened out or angular in shape. Some possess a thin sericite-looking rind, others are coated with a ferriferous hydrate. The pebbles consist of quartz, which is at times porous. The form of the cavities and the presence therein of a coating of a ferriferous hydrate causes the author to surmise that these cavities are due to the decomposition of iron pyrites, which he considers was originally present in the quartz. Through this alteration the quartz gains that "eaten" appearance (Zerfressenes Aussehen) which is so highly characteristic for auriferous quartz. Wherever gold is to be seen with the naked eye, it is mostly to be discerned in the ferriferous hydrate, which coats the cavities. This seems to favour the opinion often expressed that there exists between the iron hydrate and the gold certain genetic relations, and that in fact much, if not nearly all, of the native gold owes its formation to the decomposition of auriferous pyrites.

The rather coarse cementing-material has a similarity in appearance to arkose, and is often strongly impregnated with iron. After treating the cementing-material with HCl, the residue consisted of grains and chips of quartz (very incompletely rounded), flakes of bleached mica, decomposed felspar, and numerous granitic fragments—carbonates were wanting. The cementing-material, the author concludes, is therefore to be considered as originating from granites or gneisses.

The Witwatersrand consists of sandstones, very similar to the Table-Mountain-sandstone of Cape Colony, and of dolomites, which belong to the palaeozoic age. The same age must be ascribed to the auriferous conglomerates, which are interstratified in the above, and which can only be regarded as a shore-deposit owing to the incomplete rounding the material has undergone. Hence the rocks which contained the auriferous veins could not have been far distant from the conglomerates. As a matter of fact granitic and syenitic rocks are met with in the same chain, *e.g.*

on the Rietspruit between Grobler's and Müller's Farm on the road from Potchefstroom to Pretoria over Wonderfontein. On the south flank of the Witwatersrand, in the neighbourhood of Doorrfontein and Witfontein, are to be found sandy beds, very rich in iron, on which the quartzite sandstones and dolomites lie unconformably. The auriferous quartz-veins are considered, therefore, as belonging to these old eruptive-rocks and strata. Such veins must have been extremely numerous and extensive in order to form the conglomerates, which are known as extending to more than 65 kilomètres. Gold is not rare in later formations of this type, and is known for instance as occurring in Brazil in close breccias and conglomerates called Tapanhoacanga, and in California in the "deep placers," which are ascribed to the newest Pliocene; but palaeozoic conglomerates appear to be very rare and were formerly only known in Australia,[1] and Tasmania. Hence their discovery in the Transvaal is interesting.

In the second paper the author discusses the opinions that have at various times been expressed with regard to the mode of origin of alluvial gold ("Seifengold").

After a statement and criticism of these views Prof. Cohen concludes that the grounds for believing that the "Seifengold" owes its origin largely, if not completely, to a precipitation *in loco* through reduction of auriferous solutions, are not sufficient to warrant exclusion of that which derives it from the mechanical destruction of the original veins. To its mechanical origin are due the following phenomena:—

(1). Alluvial gold and auriferous quartz-veins are usually found in proximity to each other;

(2). The gold is coarsest in grain in the vicinity of the veins, and becomes finer in proportion to its distance from them, a result to be expected from a levigation process;

(3). The occurrence of gold in "pockets," which can only be explained by mechanical deposition; and

(4). The occurrence in isolated leaves and grains. Had, for instance, a chemical reaction taken place, crystallisation and aggregation would probably have been the result.

The surface of the gold is further rarely rough or uneven.

A chemical origin seems also opposed to the fact that, with the exception of ferriferous hydrates, scarcely any of those minerals which are characteristic for secondary products occur in association with the "Seifengold."

---

[1] R. Daintree. Note on certain modes of occurrence of gold in Australia. *Quart. J. of Geol. Soc.* 1878. XXXIV. No. 135, p. 435.

Silica has certainly been noticed as intergrown with the gold,[1] but this is a rare observation, and can only be regarded as a local phenomenon. As a result of personal experience in South Africa, the author is more inclined to consider that by far the greater portion of alluvial gold owes its present position and mode of occurrence to the mechanical destruction of older "Lagerstättte," whereby the gold became free, undergoing a natural levigation process, and eventually being mechanically deposited. He is, however, led to believe that a precipitation from solutions does actually occur, but judges its part in the process to be but small.

During his visit in 1873 to the gold fields near Eersteling, not far from Marabastad, in North Transvaal, Prof. Cohen had the opportunity of collecting auriferous quartz from Button's Reef, also specimens of the gold obtained by "washing" on Button's Creek, some few kilomètres below the auriferous vein, to which the alluvial gold owes its origin.[2] Analyses were made with the view of noting the relation of the quantity of silver in the vein-gold to that present in the alluvial gold of Eersteling. The external differences between the two varieties are marked. The alluvial gold forms flat grains and leaves rounded on the edges, and possess not infrequently a bent-up edge: the colour is golden yellow (*"goldgelb"*). The vein-gold is much lighter in colour, and is "twig-like" in form.

The following composition may be given as the result of the analyses:—

I. is vein-gold, separated as far as possible from the quartz and iron hydrate.

II. A piece of alluvial gold, 2·4 grams in weight; rendered as free as possible from the associated materials.

III. Leaves and grains of alluvial gold: mean of the two analyses given by Prof. Cohen.

	I.	II.	III.
Residue (= quartz)	0·02	0·78	0·07
Silver	5·16	6·49	4·61
Gold	94·48	91·38	95·01
Copper	0·25	0·09	0·11
Iron	trace	trace	trace
	99·91	98·74	99·80

[1] With reference to the solubility of gold, reference may be made to Bischof, *Lehrb. d. chem. u. physikal. Geologie*, 2nd Ed. III. 838-843; also Wurtz, *American Journal of Science* (2), 1858, XXVI. 51-52, and Skey, *Chemical News*, 1874, XXX. 172-174.

[2] *Neues Jahrbuch*, 1873, 511-515; also Götz in the same: Beilage, Band IV. 110-177.

If the copper and the residue be left out of consideration and the analyses be reckoned to 100, then the mean is the following :—

	I.	II.	III.
Gold	94·82	93·37	95·42
Silver	5·18	6·63	4·58
	100·00	100·00	100·00

The results are certainly remarkable, as tending to support the statement made by Devereux[1] and others, that the larger the grain of the alluvial gold the greater the amount of silver it contains. Although large nuggets are mostly confined to the alluvium, still such masses have also been observed in the auriferous veins ; in fact they seem in certain districts to occur more frequently in the latter. Burkart[2] writes : " It is remarkable that larger masses have not been found in the alluvial workings in California, since such certainly occur in the quartz-veins." Further, J. S. Newberry specially mentions the fact that the largest Californian nugget (63½ kilos. in weight) came from a vein (Monumental Mine, Sierra Buttes[3]). Whitney[4] confirms this occurrence, whilst Posepny' considers that the formation of large masses of native gold in a vein admits of a much easier explanation than the formation of the same in detritus.[5]

Prof. Cohen has treated this vexed question in his usual masterly manner, but reference must be made to the original paper for the details of the subject. J. S. HYLAND.

G. GREIM. *Die Diabas-contactmetamorphose zu Weilburg, a. d. Lahn* (with Plate). *Neues Jahrbuch*, 1888, I. pp. 1-31.

The author treats in this paper of the contact phenomena observable between diabase and Cypridina beds at Weilburg. The diabase is described as being more or less decomposed, with crystals of albite and calcite on the faces of the joints. The grain varies from fine to coarse, becoming more compact as the junction is approached. The constituent minerals are plagioclase (optically shown to be Ab_1An_2), augite, viridite, hornblende (present as small irregular patches enclosed in the viridite), magnetite,

---

[1] The occurrence of Gold in the Potsdam formation. Black Hills, Dakota. *Trans. of the American Institute of Mining Engineers*, 1882, X. 471.

[2] *Jahrbuch für Mineralogie, etc.* 1870, 162.

[3] A. G. Lock. *Gold, its occurrence and extraction.* London 1882, p. 796.

[4] Lock. *l.c.* p. 782.

[5] *Zur Genesis der Metallseifen. Oesterr. Zeits. f. Berg. und Hüttenwesen*, 1887, XXXV.

titanic iron ore (mostly altered to leucoxene), and pyrites. Apatite is wanting.

The sedimentary rocks, with which the diabase is in contact, are decided as being upper Devonian and as belonging to the horizon of the Cypridina beds. They lie perfectly concordant to each other, and are very much faulted. Pyrites crystals of the forms $\infty O \infty$ and $O.\frac{\infty 02}{2}$ are common to the anthracite beds that occur in the complex.

To sum up the author's results, the endomorphic contact-metamorphosis is only noticeable by the diabase becoming finer in grain the nearer the junction is approached. The exomorphic phenomena are, on the other hand, very complicated, and various stages in the alteration of the Cypridina beds can be observed. As the first stage, may be mentioned those which possess a ground-mass which does not exist in the unaltered rock, or those in which an increase in the amount of lime present may be discerned. The final stage shows itself in the conversion of the beds into what the author terms "kalksilicahornfels," which contain garnet.

From a chemical standpoint the alteration of the beds is of interest, inasmuch as the relations of K_2O and Na_2O, which, according to Kayser,[1] is of such great importance in similar contact rocks of the Harz, cannot be said to play that part at Weilburg, although the amount of Na_2O is increased: again a variation in the amount of SiO_2, which is also characteristic in the Harz, is not to be observed.

The author regards the contact-rocks as being in their characters very similar to those produced by granite, and consider them not at all allied to those known as occurring in conjunction with diabase. For a full description of the phenomena the reader must be referred to the original work, which contains several chemical analyses with a summary of the literature dating from 1835-1884. J. S. H.

On Sulphates from Tierra amarilla near Copiapo, Chili. G. Linck (*Zeits. fur Kryst.* XV. 1.)

The author gives an account, with crystallographic and chemical data, of the various species which help to build up that wonderful mass composed chiefly of iron sulphates, 100-140 feet high, which exists in the neighbourhood of Ramillas, near Copiapo, Chili. Descriptions of this remarkable formation, resulting from the decomposition of iron pyrites,

---

[1] *Ueber die contact-metamorphose der körnigen Diabase im Harz. Zeits. d. deutsch. geolog. Gesell.* XXII. p. 103.

have been given by many travellers, *viz.* Meyen, Domeyko, and Darwin. The specimens examined by the author were collected by Prof. G. Steinmann when on a journey through Chili in 1883.

The following minerals, amongst which occurs a new species "Quenstedtite," are described :—

1. Coquimbite (Breithaupt).

Colour: light bluish violet, more seldom greenish, or in quite small crystals slightly yellowish or bluish.

Observation of the crystal faces and mode of twinning showed that the mineral was rhombohedral and not hexagonal as hitherto supposed.

The axial ratio was $a : c = 1 : 1 : 5613$

not differing greatly from Rose's determination $a : c = 1 : 1 : 562$

The crystals attain dimensions of 1·5 cm. in all three directions, and have smooth and bright faces.

The optical characters were found to be in accordance with previous observations.

Etching figures, equilateral triangles on the base OR, and isosceles triangles on the faces of the positive rhombohedron were obtained by treating crystals with warm water, to which a little hydrochloric acid had been added.

Cleavage equal and imperfect along ∞R, $+R$, $-R$. $H = 2 - 2\frac{1}{2}$.

Sp. G. at $15° = 2·105$, as determined by means of Thoulet's liquid, after coating the crystals (in size about 20-30 cmm.), with a thin layer of paraffin.

Chemical analysis gave the following result :—

SiO_2	...	...	1·29
SO_3	...	...	41·48
Fe_2O_3	...	...	27·86
Al_2O_3	...	...	trace
MgO	...	...	trace
H_2O	...	...	28·77
			99·40

Corresponding to the formula $Fe_2S_3O_{12} + 9H_2O$.

Solubility.—Slowly, but completely soluble in water, giving a solution with acid reaction and sharp astringent taste from which basic sulphates separate on boiling.

On exposure, crystals become coated with a white powder owing to loss of water.

The only two known localities for Coquimbite are Tierra amarilla and

Sierra Gorda, near Caracoles, Bolivia, to which must be added Coquimbo if Dana's Blakeite turn out to be identical with Coquimbite.

2. Quenstedtite (Linck).

This new mineral, named after Prof. F. A. v. Quenstedt, was found accompanying Coquimbite in reddish-violet transparent tabular gypsum-like crystals, which attained dimensions 5 mm. in length, 1—2 mm. in breadth, and 1 mm. in thickness.

System—monoclinic.

$$a : b : c = 0{\cdot}3942 : 1 : 0{\cdot}4060$$
$$\beta = 77°58'$$

Observed forms {010}, {110}, {350}, {011}, {0 . 11 . 10}, {085}, {074}, {0 . 15 . 8}, {094}, {052}.

The plane of the optic axes lay in the clinopinacoid, and the first mean line is inclined to the vertical axis at an angle of 21°.

Double refraction—weak and negative.

Perfect cleavage along the plane of symmetry, less perfect along the orthopinacoid.

$H.=2{\cdot}5$

Sp. G. at 13°=2·1155 as determined in oil by means of the pycnometer.

Extremely soluble in water, forming a thick oily slightly yellow solution which has a sharp astringent taste and deposits basic salts on warming. Analysis gave the following result :—

SO_3	...	...	39·83
Fe_2O_3	...	...	27·66
Al_2O_3	...	...	trace
CaO	...	...	0·40
MgO	...	...	trace
H_2O	...	...	31·55
			99·24

Corresponding to the formula $Fe_2S_3O_{12}+10H_2O$.

3. Copiapite (Haidinger).

Bright transparent crystals of sulphur-yellow colour, which attain dimensions of 2½ mm. in length and breadth, and ½ mm. in thickness.

Monoclinic.

$$a : b : c = 0{\cdot}4791 : 1 : 0{\cdot}9759$$
$$\beta = 71°{\cdot}56'$$

These are three types of crystals in all of which the face (010) is prominent, giving them a tabular form.

Double refraction is weak and negative. Pleochroism very distinct; along *a* dark sulphur-yellow, along *b* colourless to yellow, along *c* greenish-yellow. The absorption is $a > c > b$. Cleavage perfect along the plane of symmetry (010), less perfect along $(\bar{4}09)$.

$H.=2\cdot5-3$. Sp. G. at 13°C=2·103.

Easily soluble in a little water to a thick yellowish liquid, which has an acid reaction, and becomes cloudy on boiling. The mean of many analyses made in pure material gave the following result :—

SO_3	...	...	38·91
Fe_2O_3	...	...	30·10
Al_2O_3	...	...	trace
CaO	...	...	trace
H_2O	...	...	30·74
			99·75

Corresponding to the formula $Fe_4(HO)_2(SO_4)_5+18H_2O$.

To Copiapite belongs the "Misy" of Rammelsberg.

4. Stypticite (Hausmann).

In cylindrical or radiating fibrous aggregates of a yellowish-green colour and silky lustre. In warm water the mineral decomposes, with separation of a brown substance. $H.=2-2\cdot5$.

Sp. G. at 13°C.=1·857. System probably monoclinic.

Chemical analysis gave the following result :—

Insoluble in HCl...			0·63
SO_3	...	...	32·94
Fe_2O_3	...	...	32·43
Al_2O_3	...	...	trace
CaO	...	...	0·40
MgO	...	...	trace
H_2O	...	...	34·32
			100·72

The formula proposed by the author is $Fe_2(OH)_2S_2O_8+9H_2O$.

5. Römerite (Grailich).

This mineral occurred in chestnut-brown crystalline masses. System triclinic.

$$a : b : c = 0{\cdot}9682 : 1 : 2{\cdot}6329$$
$$\alpha = 116°2'$$
$$\beta = 94°41'$$
$$\gamma = 80°8'$$

The brachydiagonal zone is specially rich in faces.

The crystals are tabular along {001} OP and generally lengthened along the axis a. Double refraction weak and negative: dispersion strong $\rho > v$. Pleochroic, the absorption being $b > a = c$. Basal cleavage very perfect. $H.=3-3{\cdot}5$. Sp. G. at 13°=2·102. Extremely soluble in water, forming a brown solution with strongly acid reaction from which basic salts separate on warming. Chemical analysis gave, as a mean of many determinations made on pure material, the following result:—

SO_3	...	...	38·47
Fe_2O_3	...	...	17·62
Al_2O_3	...	...	1·02
FeO	...	...	9·06
CaO	...	...	trace
H_2O	...	...	34·10
			100·27

Corresponding to the formula $Fe(Fe,Al)_2S_4O_{16}+15H_2O$.

6. Halotrichite (Glocker).

Occurs in white fibres having a silky lustre. System triclinic. Completely and easily soluble in cold water, forming a colourless solution having an acid reaction.

$H.=2{\cdot}5$. Sp. G. at 13°=1·885.

Analysis gave the following result:—

SO_3	...	...	33·98
Al_2O_3	...	...	10·43
Ti_2O_3	...	...	0·95
FeO	...	...	5·55
CaO	..	...	0·69
MgO	...	...	0·78
H_2O	...	...	46·94
			99·32

Corresponding to the formula $FeAl_2S_4O_{16}+24H_2O$.

Review.

Manuel pratique de Cristallographie. Par G. Wyrouboff. Paris, 1889.

This manual, which, the author remarks, should have had for its title "Manuel pratique de la détermination des formes cristallines," consists mainly of a series of well chosen and judiciously solved examples of crystallographic calculation in the various systems, to which are prefixed a few brief and remarkably lucid chapters upon geometrical and graphic methods and measurement. It may be questioned whether books upon crystallographic calculation deserve to be written at all, since they introduce complexity into a subject of real geometrical simplicity; it is only necessary, for example, to master several pages of Miller's Tract on Crystallography, and to understand the solution of a spherical triangle, and, for the rest, individual practice will enable the learner to acquire his own methods. M. Wyrouboff's volume, however, is to be recommended to the student in preference to other works written with the same object, because it is neither a geometrical treatise nor an application of any special formulæ, but a collection of examples which are solved with the elegant methods and notation introduced by Miller, so that the book should be of great use to those who wish to teach themselves how to measure and describe crystals.

The English reader will regard as unnecessary the solution by plane angles and polar triangles which is in each example given as an alternative to the more direct method of calculation by dihedral angles and poles of the faces, and will regret the introduction of Lévy's notation and the use of four axes in the Hexagonal and Rhombohedral system.

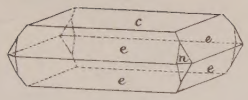
We should be glad to see more frequent use made of the convenient formulæ based upon the anharmonic ratio of four tautozonal planes, and to find some reference to the value of continued fractions in assigning indices.

The book is made more than usually readable by the fact that the author is throughout inspired by that appreciation of the physical and chemical importance of crystallography which has made his own contributions to the science of such great value; and he protests forcibly against those who "consider crystals as abstractions suited to exercise the ingenuity of geometricians and designed to supply subjects for mathematical speculation," instancing the German school founded by

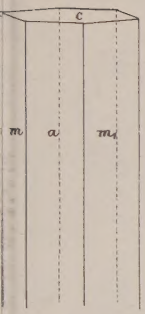
Weiss as having ended "by making crystallography the most repulsive and sterile branch of knowledge." All M. Wyrouboff's examples are consequently so selected and worked as to illustrate something more than geometry, and to satisfy the practical requirements of the student. In the same spirit he insists repeatedly on the necessity of always selecting axes as nearly rectangular as possible, so as to give clear expression to the relations between isomorphous substances (*e.g.* the oblique iron sulphate and rhombic magnesium sulphate); it appears to us, however, that this may be carried too far, and that reference to rectangular axes may sometimes conceal as much as it reveals concerning crystalline structure. When planes which do not occur upon a crystal may receive simple indices while those of common occurrence are denoted by complex symbols, the notation by indices seems in great measure to lose its convenience. The book closes with a useful sketch of optical properties. Here ferrous sulphate, which is used to illustrate the determination of optical characters, does not seem a happily chosen example, since a comparison of the results obtained by Kobell, Eratejeff, Des Cloizeaux and the author shows that there is still considerable doubt with regard to the optical characters of this salt.

The plates are excellent with the exception of one or two stereographic projections in which the poles are placed in impossible positions.

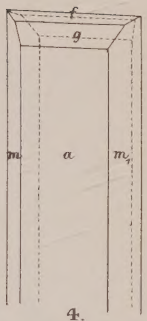
H. A. M.



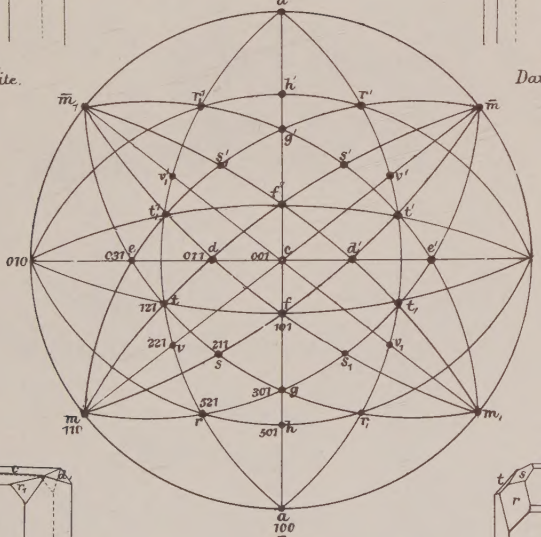
1.
Wulfenite.



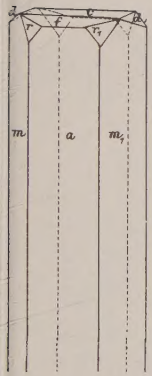
3.
Daviesite.



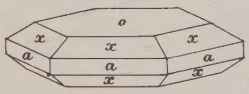
4.
Daviesite.



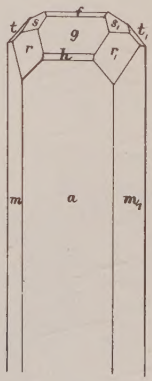
7.
Daviesite.



5.
Daviesite.



2
Caracolite.

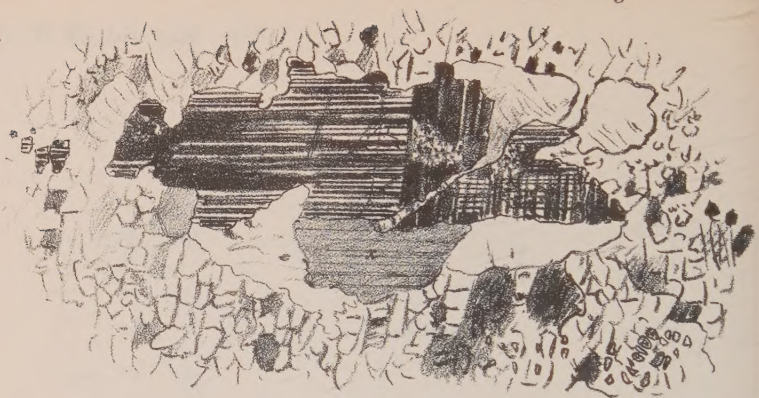


6.
Daviesite.

Crystals from Sierra Gorda.

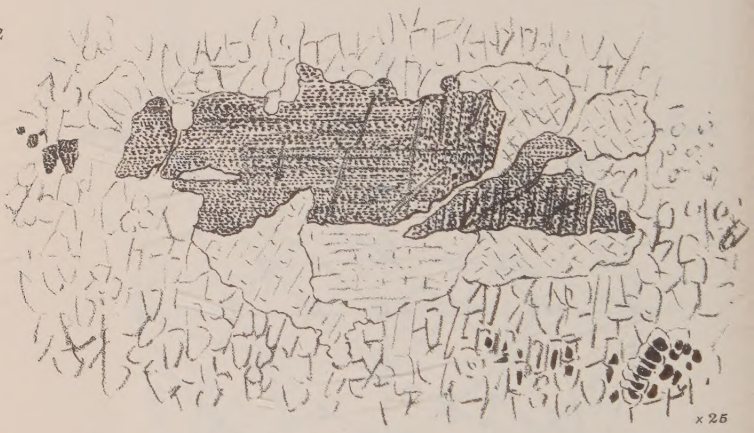
Mintern Bros. lith.

1



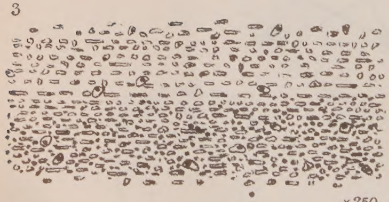
x 25. *n*+

2



x 25

3



x 250

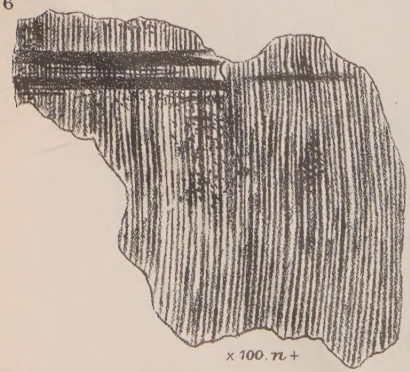
4

x 2500

5

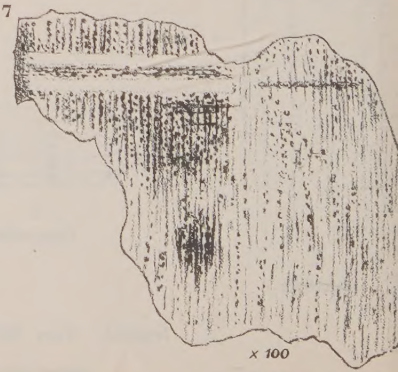
x 100

6



x 100. *n*+

7



x 100

Parker & Coward del. et lith.

West, Newman & Co. imp.

CONTENTS OF No. 39.

		PAGE
FLETCHER.	On Crystals of Percylite, Caracolite, and an Oxychloride of Lead (Daviesite) from Mina Beatriz, Sierra Gorda, Atacama	171
CHURCH.	Note on Colorado Hydrophane	181
PRIOR.	Note on Connellite from a New Locality	182
SOLLY.	Pseudomorphs of Hæmatite after Iron Pyrites. With Analysis by A. Hutchinson, B.A.	183
JUDD.	On the Processes by which a Plagioclase Felspar is converted into a Scapolite. With a Plate	186
HEDDLE.	On the Occurrence of Gyrolite in India	199
HEDDLE.	On Dudgeonite, Hydroplumbite, Plumbonacrite, and Plattnerite	200
MIERS.	Mineralogical Notes.—Polybasite; Aikinite; Quartz; Cuprite; the Locality of Turnerite	204
	Abstracts and Review	210

CONTENTS OF No. 38.

CHESTER.	A Mangano-magnesian Magnetite	125
HEDDLE.	On the Zeolites of Rye Water, Ayrshire	127
HEDDLE.	The Minerals of the Treshinish Islands	130
MORRISON.	Elaterite: a Mineral-Tar in Old Red Sandstone, Ross-shire	133
MACADAM.	Analyses of various Mineral Substances	135
FLETCHER.	The Renaissance of British Mineralogy	138
FLETCHER.	On the supposed fall of a Meteoric Stone at Chartres, Eure-et-Loir, France, in September 1810	146
MIERS.	Calcites from the neighbourhood of Egremont, Cumberland	149
HOLLAND.	On the large Porphyritic Crystals of Felspar in certain Basalts of the Isle of Mull	154
DICK.	A New Form of Microscope	160
	Abstracts	164

ORIGINALLY PRINTED IN GREAT BRITAIN BY MESSRS. WILLIAMS AND STRAHAM, LONDON. REPRINTED OFFSET LITHO BY BIDDLES LTD., THE CITY PRESS, GUILDFORD, SURREY